In this Issue
U. S. A.-BRITAIN OUT-PRODUCE NAZIS
by T. P. Wright

NO
19

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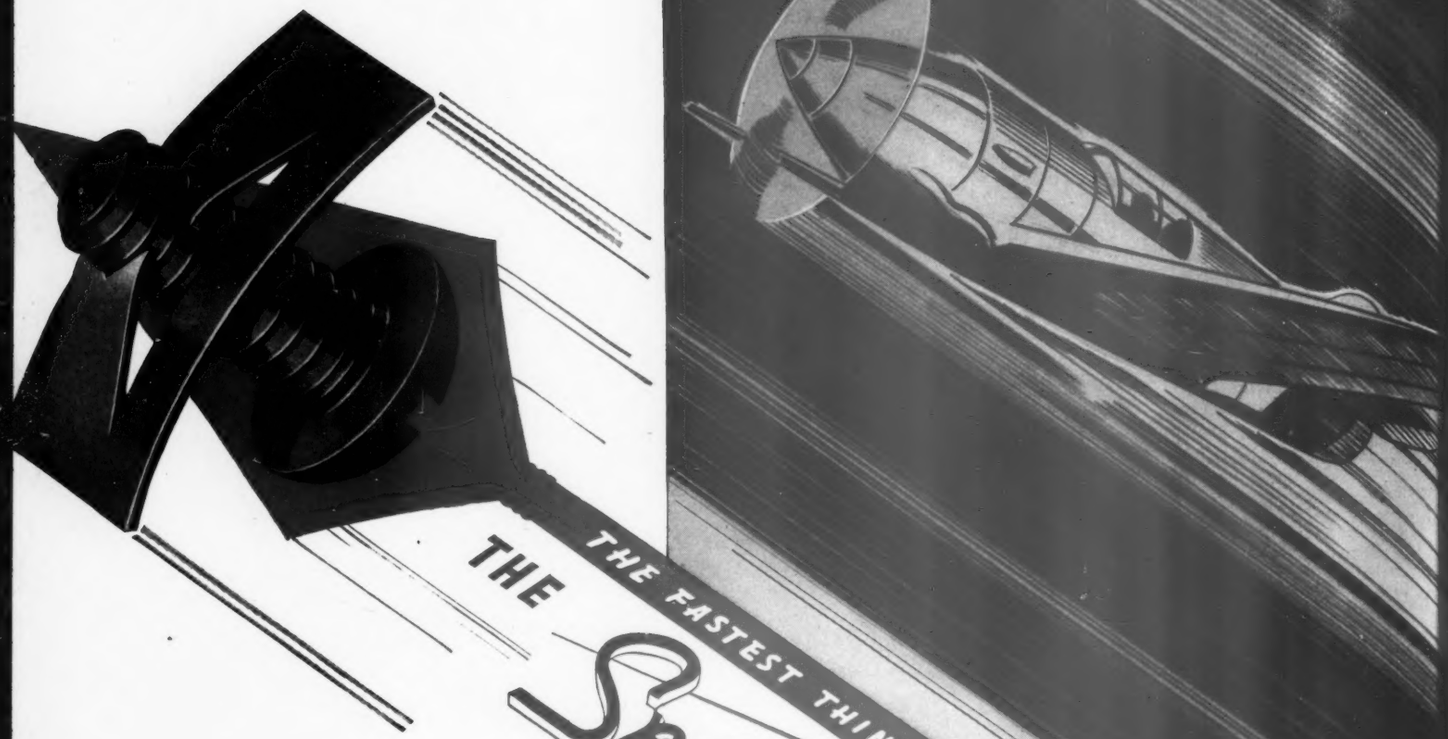

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Aviation in indexed in Guide to Periodical Literature and in Industrial Arts Index.

"REPORTING FOR DUTY" by John Hammer

REPORTING FOR DUTY...On schedule, another Republic fighting plane completes its delivery flight. No arrival is more welcome to the pilots of the Army's interceptor commands, who daily chronicle the unsurpassed performance and dependable power of these high-altitude pursuit airplanes. Republic Aviation Corp., Farmingdale, L. I., N.Y.

REPUBLIC AVIATION

REPUBLIC AVIATION

How Big is a Trickle

» WHILE WE HAVE FREE SPEECH, a free press, and that venerable institution of Congressional grandstand play, there is nothing to prevent columnists and congressmen from influencing the thinking of our people. But we cannot leave all of this ranting about the ineffectiveness of the aircraft production program unchallenged.

» STARTING GUN in the most recent disparagement of the efforts of the aviation manufacturing industry was fired by Senator Byrd who artfully picked a period when long range bomber production was retarded by a model change, and announced that we were falling down on the job. About the same time a widely read columnist returned from England to tell us that lease-lend material was reaching the front line in a pathetic trickle. These thoughts were echoed far and wide and picked up exaggeration like a rolling snowball. It wasn't long before national publications began to present pictures of American factories under construction for a future program beside those of British factories humming with activity. The inference is both inaccurate and misleading, and this is not a good time to undermine public morale by totally unjustified criticism of the job being done.

» WE AREN'T OUT OF THE WOODS YET by any means but we have exerted an almost superhuman effort in the first 15 months of the air defense production program. There are even more difficult jobs ahead. But the performance of the aviation manufacturer so far has been so effective that there is certainly no need for apologies. What is being done with the aircraft produced, however, is a matter beyond our control. Let's take a quick look at the production record.

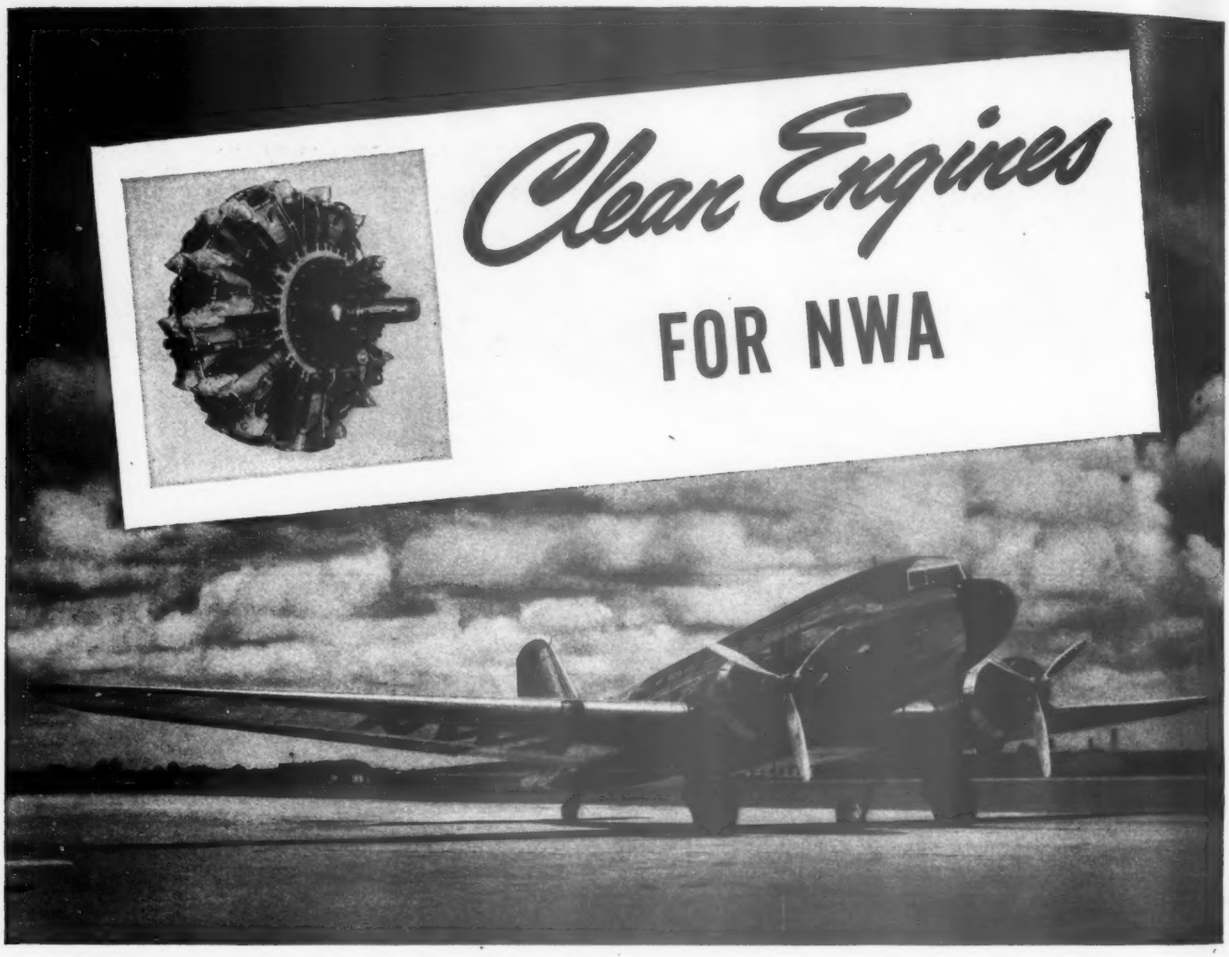
» WITHOUT EXTERNAL HELP the aircraft industry has increased production four-fold since the program began. It is true that about one-half of present production is training planes, but that percentage will be materially reduced as the totals increase. Let's not forget that there are concurrent pilot training programs which are fully as important as the production project. There is no point in making the German mistake of building huge reserves of combat aircraft which had to be kept in storage until pilots could be trained to fly them.

» WE HAVEN'T BUILT enough long range bombers. Neither has anybody else. There are many who believe that the war could be won right now by anyone who had enough of these ships. But no one started to build them soon enough. It takes just so much time to build them, there are only two manufacturers turning them out now, and they are doing a splendid job. We wish we could avail ourselves of the Senatorial privilege of releasing the confidential production figures on this type. We won't, but if we did, you would be even more agreeably surprised than we were when we learned them.

» THIS IS FORTUNATE because we must depend entirely on the production of these two manufacturers for many months to come. We cannot expect contribution from either the automotive industry or from the other aircraft makers who are being transformed into manufacturers of bombers or bomber parts. There is almost as much difference between the jobs as there is between the building of speedboats and ocean liners.

» ON MEDIUM RANGE BOMBER PRODUCTION we are better off because we were permitted to start sooner. We wish we could tell you how many were delivered to the British last month, but all we can say is that the number was very satisfactory. It must be remembered that many of these and many other airplanes were delivered to the British in fulfillment of contracts made prior to the lease-lend era.

» THERE'S ANOTHER POINT that many people don't realize. It is this business of stopping production for model changes. This is the only sound method of keeping an air force up-to-date, and it is so important that it may easily be the determining factor in winning the war. Each day we are learning real combat lessons that cannot be learned except in actual warfare. Each day we are improving equipment for our aircraft. It would be criminal for



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RETURN METAL DRUMS PROMPTLY . . . thus helping to make present supply meet industry's needs and releasing metal for National Defense.

us to sit by and fail to incorporate these lessons and improvements into our production airplanes.

» WE HAVE SEEN AND WILL SEE AGAIN production stoppage for model change. And we will see new designs introduced into the production program along the way. Some of our engines are undisputably the largest and best in the world now. Larger power plants are undergoing installation tests and still larger ones are being run in test houses. Highly important results are soon to pop out of the propeller design laboratories and into the factories. These and other things will enable our bombers to fly longer, faster, higher, and to carry more bomb tonnage than those of other nations. They must be incorporated into the program as soon as they are available.

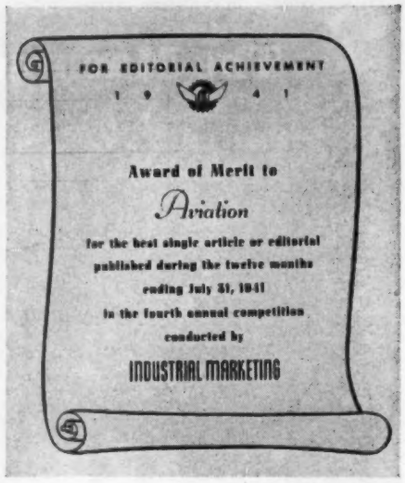
» BECAUSE of the misunderstanding that may have arisen in the minds of our readers we are again privileged to present the true facts of the defense procurement program and to report on the accomplishments of the industry and its effect on our position with respect to the nations at war.

» THE CHAMPION CONSUMER OF ELECTRIC POWER for night work is O.P.M.'s T. P. Wright who needs no introduction to AVIATION'S readers, nor to the 2,000,000 readers of the other publications that quoted his last contribution to AVIATION. Last month he ran up his electric bill again to give you the lead article in this issue. We realize full well that it borders on imposition for us to ask the author to add to his already heavy burdens in the key position he holds in the defense procurement picture. But we have grown weary and indignant at all those who strive to belittle the performance of the aviation industry in its expansion for defense. It is our duty to present the record as it stands with neither optimism nor pessimism. And it is your duty to judge it on its merits.

» 1941 WILL GO DOWN IN HISTORY as the greatest year in aviation industry expansion. It will see our production attain and surpass that of England, which was reached only after several years of heartbreaking work. During this year we will pass beyond the period when our military airplanes, plus the British production, will reach parity with that of the Axis powers. We will end this year with the satisfaction of knowing that, because of the splendid efforts of our aviation industry, America has awakened in time.

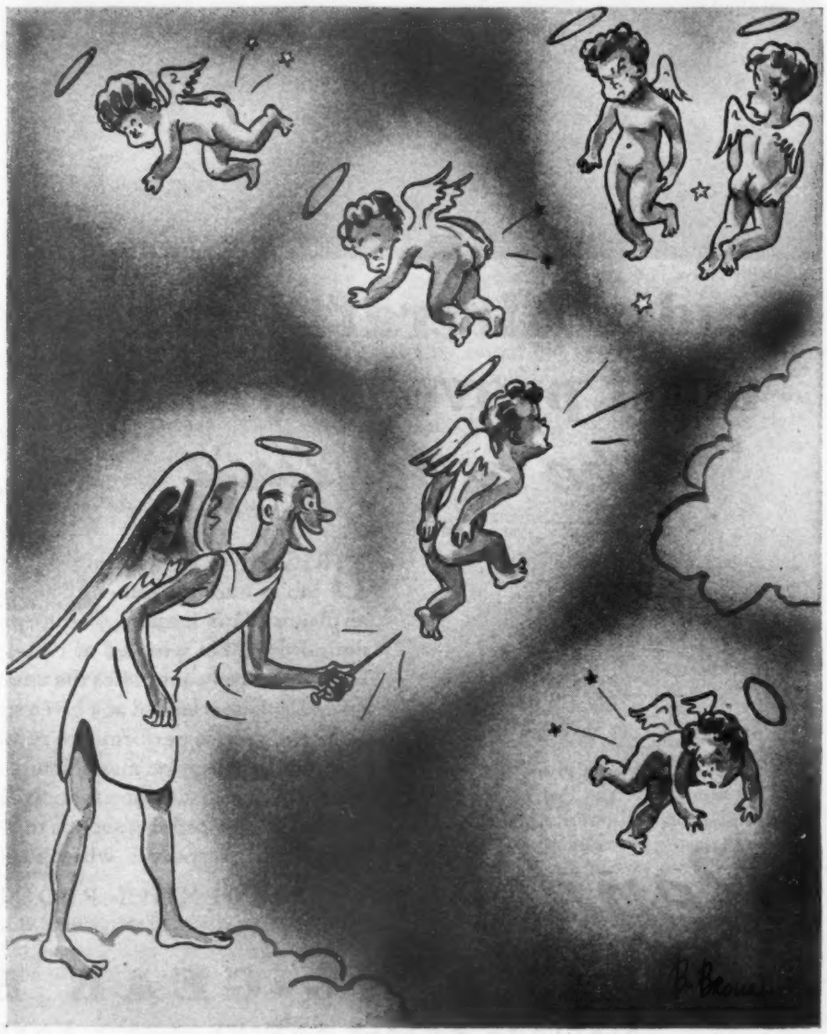
» THIS ISN'T IDLE CHATTER. It is all borne out by the charts in Ted Wright's article on page 46. But we cannot resist a little boasting about the author's early estimates. To show their uncanny accuracy, we have reproduced the identical curves, drawn a year ago, and spotted the actual figures on them. Most of the actual figures fall exactly on the prediction curves. A very few have fallen off by almost negligible quantities. A glance at these charts will convince you that you may rely completely on the author's future estimates.

» WHILE WE ARE BOASTING we may as well tell you that the article in which Mr. Wright made these estimates won for AVIATION the Industrial Marketing Award of Merit for the best single article or editorial published during the twelve months ending July 31, 1941, in their fourth annual competition. We

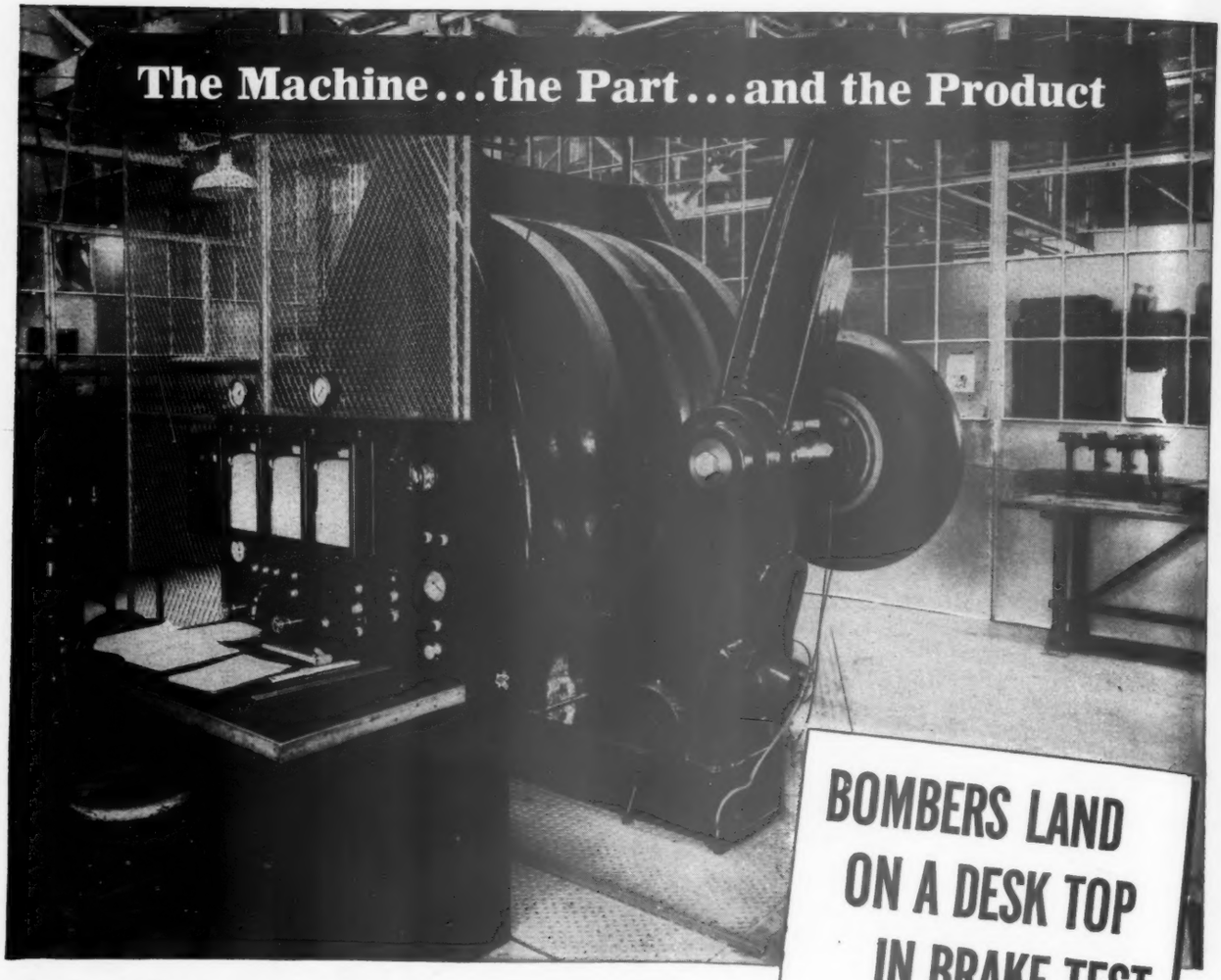


are deeply grateful for this appreciation. But there is even more satisfaction to be derived from the assurance that we are giving you the real facts and figures of the record and that the earlier predictions have stood the test of time.

SAVE TIME BY AIR



Maguire seems to be taking that "Keep 'Em Flying" slogan too literally!



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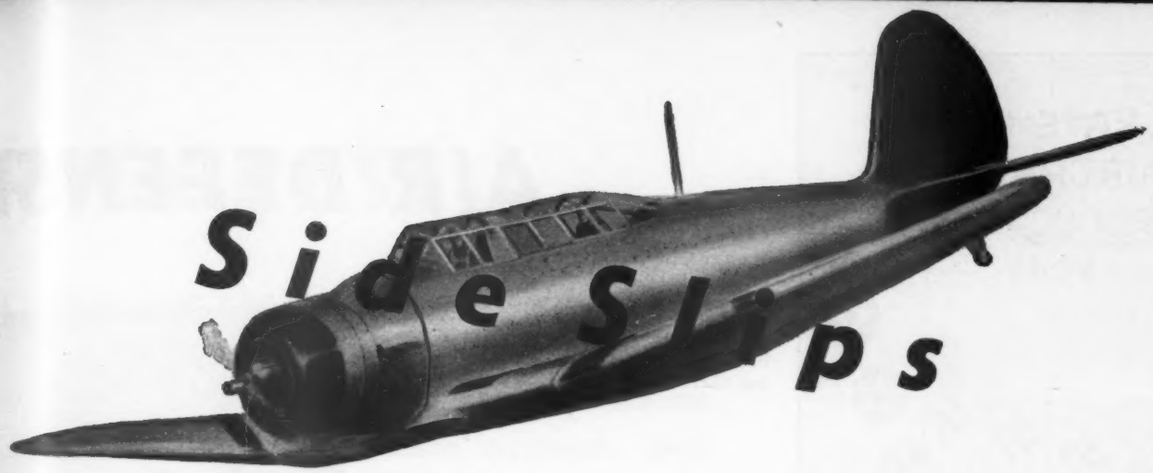
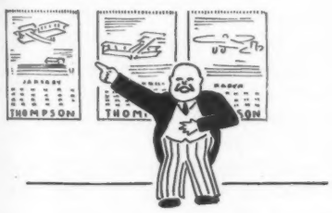


SideSlips

» ONLY TWO MORE MONTHS till 1942 calendar time! If you're planning a calendar to end all calendars, have a care. Take a tip from Thompson Products. For these people, who modestly call themselves "manufacturers of automobile and aircraft parts," did the trick *last* New Year, in our opinion.

If you haven't seen Thompson's "Dawn of Wings"—a lithographic symposium of early airplanes, you are a babe in the woods, totally unprepared to tackle the problem of keeping your 1942 killer-diller calendar out of the nearest waste basket.

Why gentlemen of the Board, Thompson's calendar stops them cold! The Customers take it apart and make murals out of it! They don't even cut the add off the bottom. It's stupendous! Why, it's—it's — — listen. This calendar is a series of 12 pictures, in color, of early airplanes. The Wright Biplane of 1903! The Santos Dumont powered box kite of 1906! Caproni's twin propeller ship of 1909, and on up to Sikorsky's four-engine cabin plane of 1913.



You can read this calendar like a book, for hours, and keep on learning things. Even for days. Yes, we're one of the guys who made a mural out of it. When we get tired of trying to figure out whether it's true that there are 16 machine guns and four cannon in the latest fighter job, we just tilt back in our swivel chair and meditate on that pretty little Grade Monoplane, vintage 1912, floating up from a green meadow like a butterfly.

» A MAN WAS A BIRD in those days. He put his cap on backwards, bought a five gallon tin of gasoline, and sailed up into the sun, with nothing between him and the ground and the sky but the seat off a Deering hay rake and a few strands of piano wire, humming in the wind.

Almost as good as the Grade monoplane, which was a parasol type, with the pilot underneath, is Bleriot's monoplane with the man on top, although it is a high wing design. Out ahead, you see the white chalk banks and you know it's the first airplane crossing of the English Channel. The caption says: "On the morning of July 25, 1909, he boarded his monoplane in Calais, France, and took off with the cliffs of Dover, England, as his goal. The 20-mile flight was accomplished in 37 minutes. His triumph was received with wild acclaim throughout the civilized world."

» TURN OVER THE PAGE, OR SHIFT YOUR EYE, if you've tacked the pictures on your office wall, and there's Glenn Martin's rugged-looking 1909 biplane, with a three-wheel undercarriage, the rudder on a boom in the rear, the elevator on a front outrigger, and the ailerons fitted to the struts half way between upper and lower wings. On the pilot's seat, in front of the radiator, wearing goggles, puttees, and a white collar and tie, is a young man. Might be Glenn Martin himself.

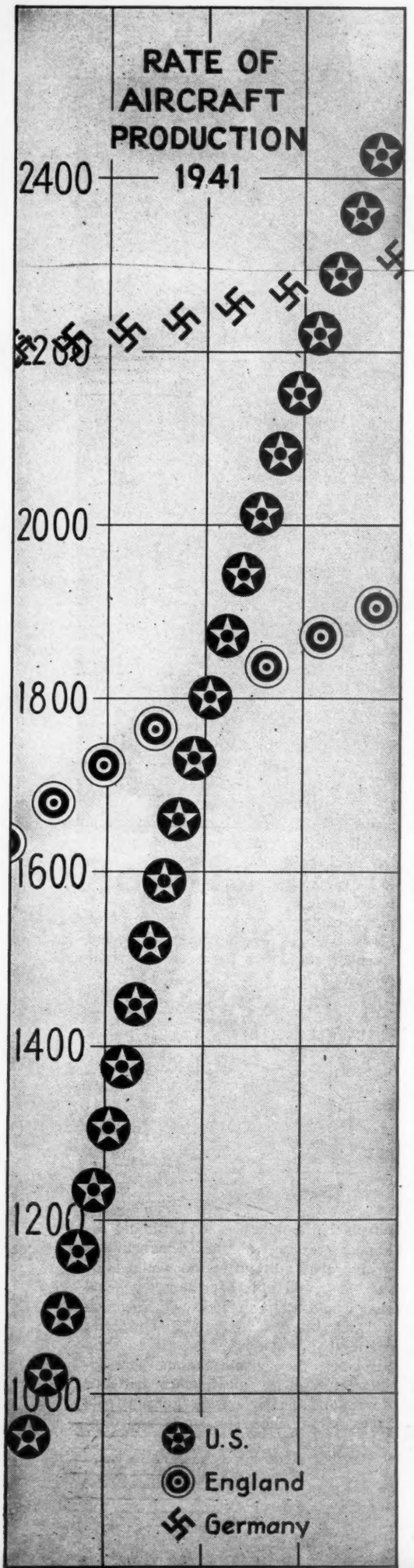
The Artist shows the Martin plane taking off a lovely pasture with high purple mountains in the background, coming right toward you, and barely clearing a stout board fence. But the pilot is not alarmed in the least. If some of the other early planes appear to offer only adventure and thrills, the Martin airplane seems to be a machine for going places; it looks strong and business-like. You would not be surprised if you could see a brief case there in Mr. Martin's lap. You get the idea that board fences and high purple mountains are out of men's way for good.

Another beauty, we think, is Sikorsky's "Grand". Here is the true beginning of the romance of the air, which, since the earth holds unlimited quantities of aluminum, bids fair to last as long as anything else does.

After building eight smaller machines, Sikorsky "designed and constructed a huge four-engine biplane which he called the Grand. This ship created a sensation," says the caption writer in high understatement. "It was by far the largest airplane in the world at the time. The wing span was nearly 100 feet and four 100 hp engines furnished the power. On initial tests, Sikorsky, four mechanics and a relief pilot, succeeded in flying 55 mph with this 9000-pound monster. On August 2, 1913, Sikorsky, with seven passengers, made a duration record of one hour 54 minutes. About a year later an improved model of the Grand carried seven passengers for a night flight lasting six hours 33 minutes, during which guests were served a hot meal.

» BUT Mr. Sikorsky, the genius from Kiev, made one error of foresight. He put a captain's bridge out in front of his cabin! There in blue-uniformed splendor stand two flight officers right

out in the 56-mile breeze. Little did Sikorsky realize, as he designed his bridge, that a mighty wind would blow 300, 400, 500 miles per hour; a wind that would scalp anybody who so much as stuck his head out in it. He didn't know that while he was still building airplanes, they would become submarines aloft, with all hatches battened down and people inside getting pale faces despite their sun lamps and vitamin tablets.



AIR DEFENSE

The record of the Aviation Industry's Brilliant Performance during 1941.

T. P. Wright

AVIATION MAGAZINE

New York City
October 1, 1941

Dear Mr. Wright:

The expansion of the aviation industry in the year 1941 is an industrial miracle. But almost equally miraculous is the fact that the industry has expanded almost exactly as you predicted in your last article, "The Truth About the Defense Program", published in AVIATION's January, 1941, issue. In the last two decades I have seen many aeronautical predictions, most of which went wrong. But I have never seen any estimates anywhere that have stood the test of time as well as have those that you made a year ago.

Each month, as the airplane delivery totals were released, I have called to the attention of our readers the accuracy of your predictions; but that is only a part of your prophecy. I wonder if you could find time, from your busy days and nights, to check over your original estimates of monthly deliveries, increases in productive floor space, direct labor, and other basic factors in our program, including the comparisons with British and Axis production rates, to show how closely our industry has followed the pattern laid down for it.

I realize fully what an imposition it is to ask you to take time for a project of this sort, but I feel that you will be rendering a valuable service to the country in again giving facts on the job done by the aircraft industry in the greatest productive capacity expansion of all time.

Sincerely yours,
Leslie E. Neville

P.S. Incidentally you will be interested to know that your article, "The Truth About the Defense Program" won for AVIATION the Industrial Marketing Award of Merit for the best article or editorial published in a business publication during the period of August 1, 1940 to July 31, 1941.

AIRCRAFT BRANCH
OFFICE OF PRODUCTION MANAGEMENT

October 10, 1941

Dear Mr. Neville:

I agree that there is a need to reappraise our effort of the past year and a half. It is difficult for me to get time to do much writing, but in this less formal way, I am pleased to give you my reactions on what has happened during this period. Naturally I am pleased and gratified that the Industrial Marketing Award of Merit was given to AVIATION because of my article in the January issue.

It has been interesting to keep track on the curves of actual airplane deliveries, point by point, as the months have gone by. The check has been good; we have done about what was to be expected. It took time to get under way, shown by the initial flat portion of the curve of monthly deliveries; then there was a period of acceleration, until we reached the very creditable rate that we are now producing. In President Roosevelt's message to Congress on September 18, asking for additional Lend-Lease appropriations, he said the following: "Planes, tanks, guns, and ships, have begun to flow from our factories and yards, and the flow will accelerate from day to day, until the stream becomes a river, and the river a torrent, engulfing this totalitarian tyranny which seeks to dominate the world." In a leading article in *Life* magazine for September 29, this quotation is referred to as "looking good" superficially, but there is the intimation that our deliveries are only a "trickle of arms to Britain." I beg leave to differ with this opinion, as I

PROGRESS

In reply to those who would attempt to discredit the miraculous performance of the aviation industry in the present emergency, we are proud to present this progress report on production expansion. How the supreme effort of our aviation manufacturers has pushed production to the point where part of ours, added to that of the British, now surpasses that of the Axis powers is told by the foremost authority on plane production throughout the world.

By T. P. Wright *Assistant Chief, Aircraft Branch, O.P.M.*

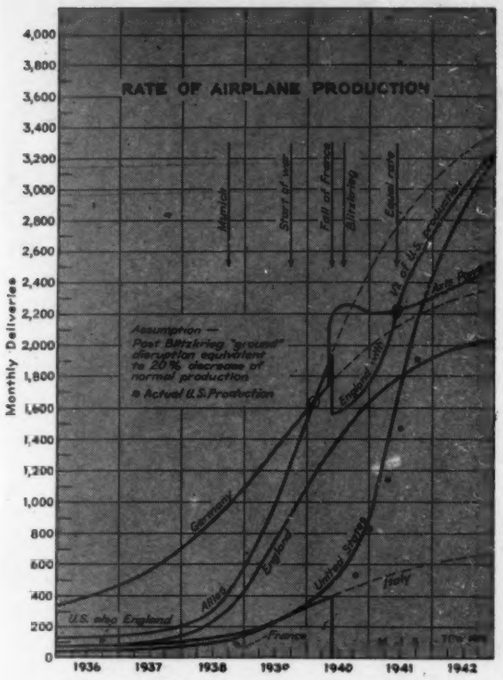
believe that the President's statement is both accurate and timely.

There is a tendency for the American people to be either extremely optimistic or extremely pessimistic as to prospects in a given situation, depending on short range circumstances. Although the present situation does not call for over-optimism, certainly extreme pessimism is not indicated. We have done a tremendous job during the past year and a half; it is really something of which we can be justly proud, to deliver aircraft now at a rate four-fold that which maintained at the start of our period of expansion about 15 months ago! We have gone from approximately 500 airplanes per month during the summer of 1940, to about 2000 in the fall of 1941, and we are only getting started at the present time. All of this increase has been brought about by accelerating deliveries from the aircraft industry itself. We are yet to receive aid from other industries given a part in the aircraft program a year ago.

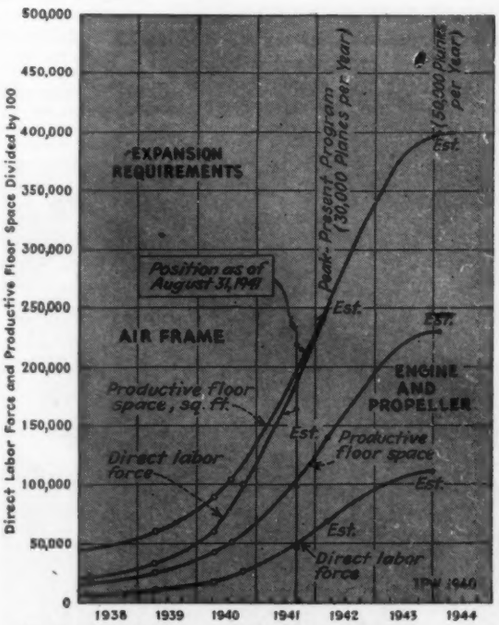
As I have pointed out in previous articles published in your magazine, morale is of equal importance with production of material. To gain morale a people must know the truth, they must know what is being accomplished, and they must feel confident that the men to whom they have intrusted the problem of increasing production output are doing a creditable job. They must appreciate the need for increased sacrifice, but as well they must recognize that the task already set has been well handled. I have previously emphasized the former. I now wish to place particular stress on the latter. A good job has been and is being done.

The meat of this letter is the accompanying set of curves of the article of last January, reproduced just as in that article, but added to by the incorporation of small dots to show actual

(*Turn to page 180*)

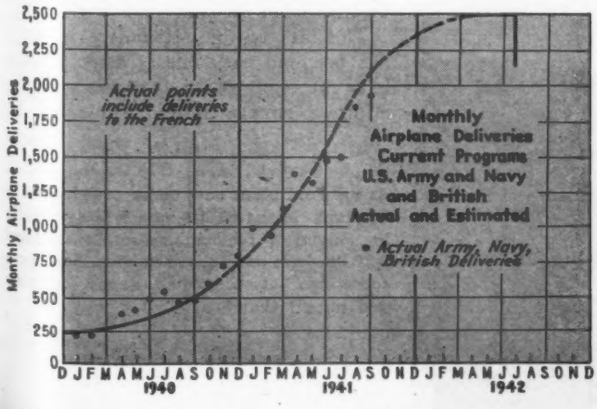


Since the predictions for all countries were made on the same basis, there is excellent reason to believe that the British and Axis estimates are as close as that for U. S.

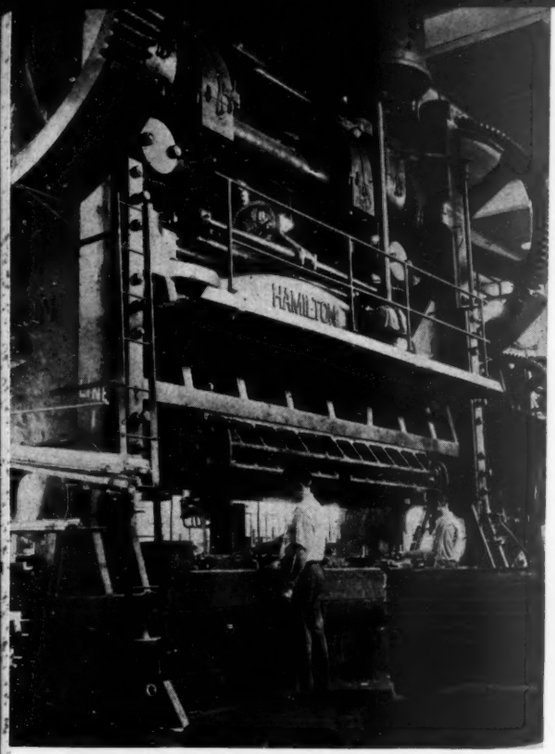


Productive floor space and direct labor are very close to schedule.

New programs provide for extension of this curve to over 3000 per month by the middle of 1942.

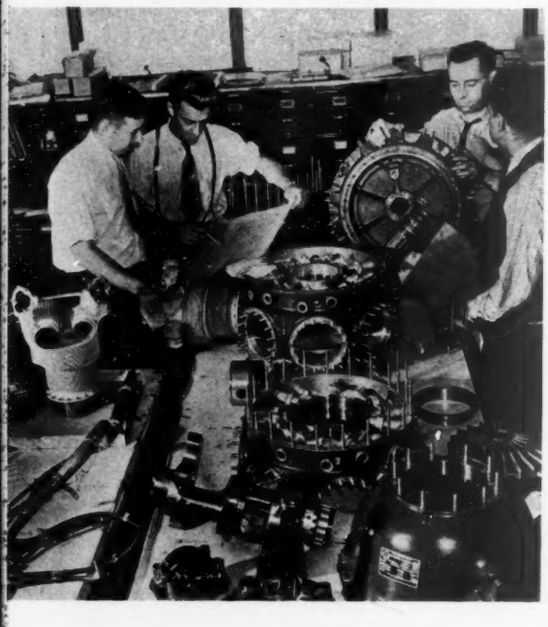

Monthly Airplane Deliveries
Actual points include deliveries to the French
Monthly Airplane Deliveries Current Programs U.S. Army and Navy and British Actual and Estimated
• Actual Army, Navy, British Deliveries
1940
1941
1942

Total production for 1941 coincides almost exactly with estimates.



More than 8,000 different stampings are made by Briggs Mfg. Co. of Detroit on this 1,600 ton press for Vought-Sikorsky wings, Boeing flaps and ducts, and Douglas wings.

Chevrolet engineers at the Tonawanda, N. Y. plant make a preliminary inspection of a Pratt & Whitney engine which Chevrolet will build. Buick and Ford are already building these engines.



Where the Auto-

With the plant-building stage almost behind to enter the pre-production phase of their activi-

By Clinton B. F. Macauley,

WITH America's peacetime aviation industry already close to Britain's war-time plane capacity, we stand on the threshold of the second phase of production expansion—the participation of the automotive industry in the manufacture of engines, propellers, airplane parts, sub-assemblies, and complete airplanes. Scarcely a year has elapsed since the automotive producers began to even plan for participation in the aviation program on any appreciable scale. Aeronautical production of the automotive industry, save for those few concerns which have been in the aviation business for years, is now only a trickle in the rising flood of aircraft production. This represents no culpability on the part of the auto industry, however. That there is any production at all after so short a period of preparation is no mean achievement—particularly when we consider the whole range of completely new problems which challenged an established industry.

Spadework Almost Completed

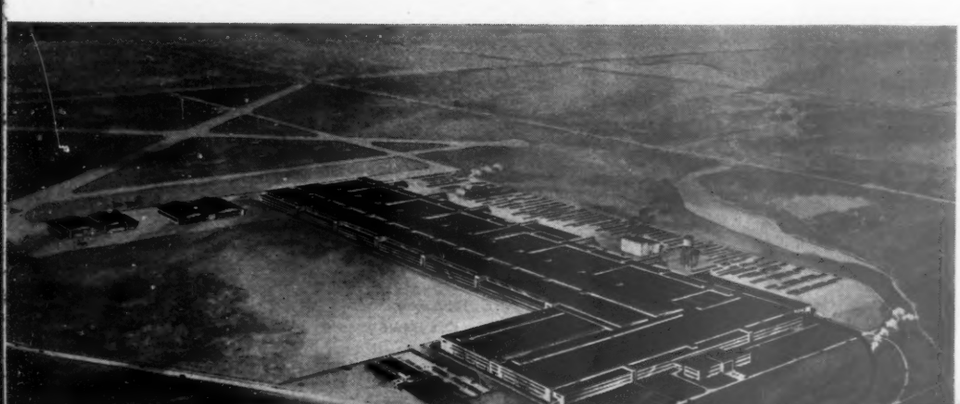
Most important, the spadework and preliminaries are substantially completed. New plant floor space running into millions of square feet has been provided by new construction and conversion of old factories, thousands of men have been trained in aviation skills, and machinery and tools have been fabricated and installed.

As the year draws to a close, this machinery and more being added daily will begin to turn faster and faster so that by the first months of next year the automotive effort will have assumed sizeable proportions in the aviation program—and by the middle of 1942 we can anticipate with confidence an appreciable volume of aeronautical production from the auto industry.

The task of the automotive industry has been no easy one. Many persons have the impression that the aviation effort is simply filling a hole left by

To secure material on automotive participation in the air defense program, C. B. F. Macauley, Washington Editor of AVIATION traveled some 2,500 miles throughout the middle west, inspecting plants, observing production facilities and talking with automobile and aviation officials.

Macauley came to AVIATION from the Civil Aeronautics Administration, where he was Chief of the Publications Section and editor of the *Civil Aeronautics Journal*. He had previously served as assistant editor of National Aeronautics and had also been Washington correspondent for several national news agencies. For the past six months his efforts have been devoted to special assignments for AVIATION.



At the Ford plant now under construction in Ypsilanti, Mich., 50,000 men will eventually be employed building entire Consolidated B-24 bombers and sub-assemblies. Architect's conception of completed shops, hangars and airport shown.

Makers Stand

them, the automobile manufacturers are about ties. After this we may expect real production.

Washington Editor, Aviation

curtailed production of regular products. This is far from the truth. On the whole, the automotive industry up to now has strained to the limit, producing not only automotive vehicles to meet growing civil demands, but trucks, tanks, prime movers, machine guns, anti-aircraft guns, and other arms of wide variety for the British as well as our own defense needs. The aviation effort has been added to this already heavy burden, requiring the highest calibre of management, labor and equipment, in all of which increasing scarcity has been a serious factor.

No Magic Solution

Contrary to much loose writing and irresponsible preachment, the automobile industry with its abundance of mechanical genius held no magic solution for the problem of expanded aircraft production. There is a variety and imperative flexibility in military aircraft production which utterly defeats all attempts, however well intentioned, to impose upon it the standard mass production methods of the auto industry.

Not that aviation cannot learn from the automotive industry. It has done so continuously ever since Kittyhawk. Mechanical developments and production methods created within the auto industry are under constant scrutiny by progressive aviation engineers who do not hesitate to adopt in their entirety or in modified form any ideas which can improve the aviation product or lead to more efficient production. The reverse is true also. The automotive industry undoubtedly will emerge from this excursion into aviation with new ideas for the application of aeronautical techniques to automotive engineering. Both industries will profit enormously because the exchange of ideas and knowledge is going on at a pace so much faster than normal circumstances would dictate.

The finest automobile motor, for example, weighs about six pounds per horsepower, as against slightly less than a pound per horsepower for our high output aircraft engines. An aircraft powerplant built along the lines of an auto motor would result in an engine weighing up to six tons, which is considerably in excess of the total weight of a single-engine combat aircraft. This is not as illogical as it would seem at first. Weight is not a primary consideration in designing a rugged and reliable engine for surface transportation. But in aeronautical design, where weight is of utmost importance in relation to performance and

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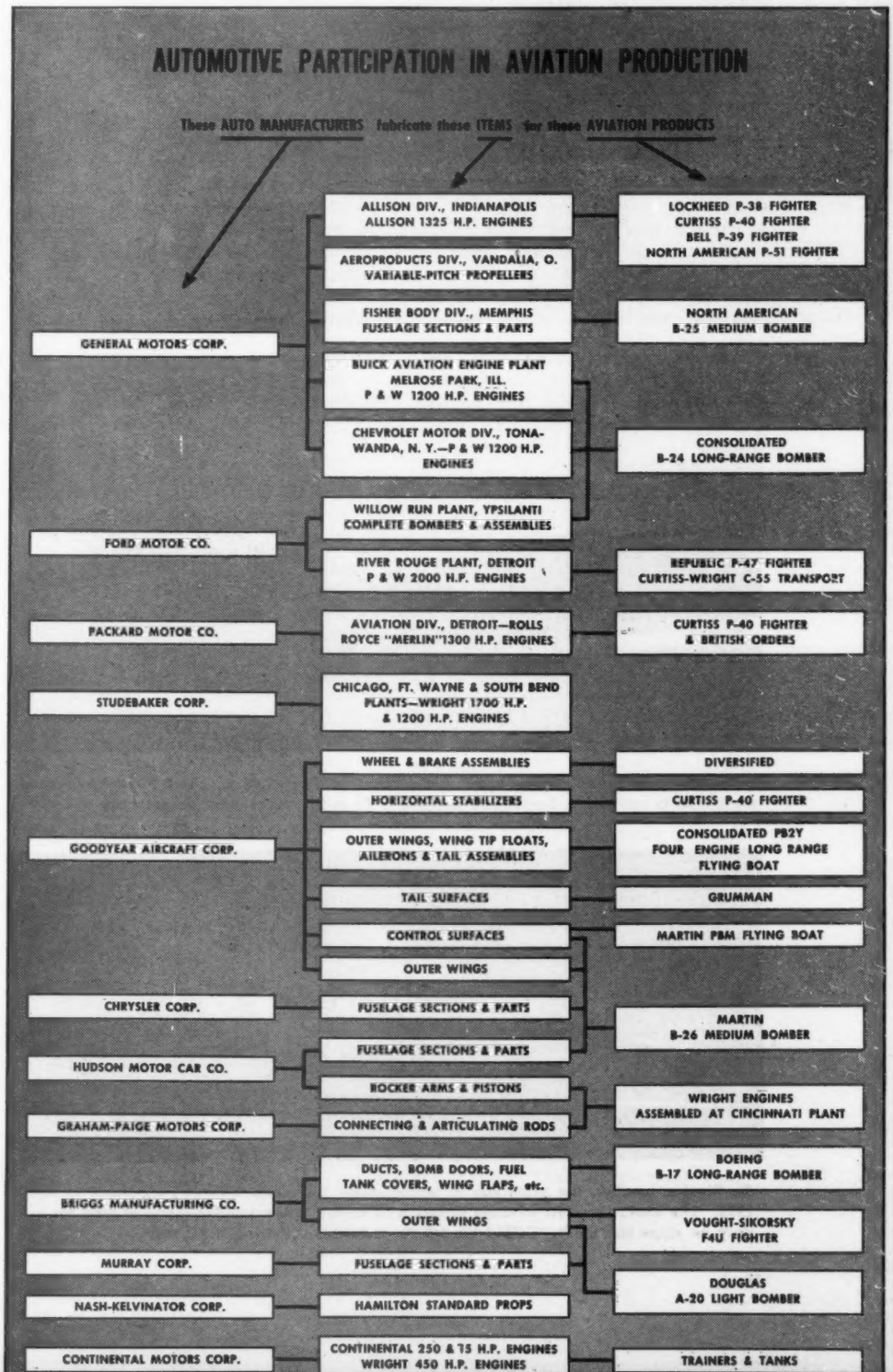


Civil Aviation Cooperates In Russian War Effort

By Lucien Zacharoff *Associate Editor, Aircraft Publications*

FOR the first time since its inauguration, one of the Soviet Union's most popular holidays, Aviation Day, was observed in August under wartime conditions. While the Red Air Force is much heard from these days, considerably less is said of the operations of the Civil Air Fleet. The Soviets have emphasized for years that they regard their commercial and sports aviation as a powerful adjunct of the fighting contingents.

The activities of the airlines and other branches of civil aeronautics have been decidedly subordinated to the all-out war effort. Civil flying has not been curtailed, but rather it has been redirected. Private travel and transport of non-essential freight is restricted. On the other hand, expansion has been registered in the aerial ambulance service, which even before the war was a prominent department of the Civil Air Fleet.

It is noteworthy that since the Nazi invasion began scores of civilian airmen have been decorated by the government, alongside the military fliers, "for exemplary and self-sacrificing execution of orders of the Red Army command in fighting German Nazism and for courage and valor displayed therein."

There was cited Pilot Andreyev. While transporting wounded soldiers, his plane was attacked by Nazi pursuits and burst into flames. Under incessant enemy fire, the pilot made a perfect landing. While the German fighters circled over them, Andreyev and his crew carried 25 seriously wounded men to a place of safety.

Another Civil Air Fleet ambulance was similarly attacked. The wounded pilot with great difficulty tried to land his craft on an island, but it hit the water and began to sink. Flight Mechanic Polyakoff, who was unhurt, saved the commander of the plane, the radio operator and all 15 gravely wounded Red Army men aboard.

Commander Riza of the PS-84, a twin-engined (air-cooled) transport, regularly flies over the front lines. In a single night he made three flights into enemy country. All flights were successful, notwithstanding foul weather and anti-aircraft fire. Although in decorating him, the Presidium of the Supreme Soviet of the USSR has not stated his mission, it is apparently a part of the Civil Air Fleet's operations nowadays to deliver to the guerrilla detachments behind the German lines their ammunition, food, literature, and perhaps to bring well-trained and armed parachuting saboteurs.

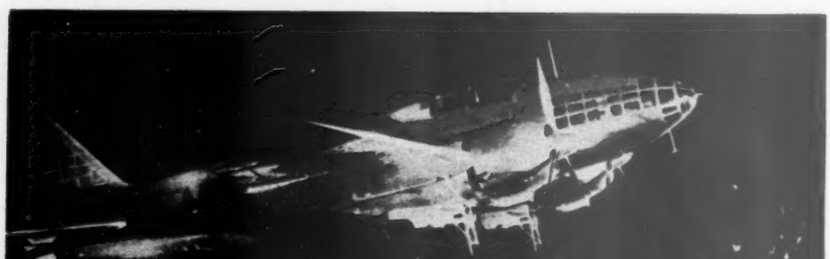
Equally renowned for his daring calls behind the Nazi lines is civilian Pilot Verveiko who, when last heard from, was attached to a Kiev unit. He flies at night and under enemy AA fire.

On the 2,000-mile front, it is all in the day's work for a civilian pilot to undergo the experience of Commander Krugloff of an ambulance plane which with a group of wounded soldiers aboard was attacked by three Messerschmitts. His ship damaged, himself badly wounded, Krugloff landed and dragged his wounded Red Army charges to safety, all this under withering German machine gun fire.

Remaining aloft 14 to 16 hours at a time, Pilot Zinchenko made over 20 flights to evacuate wounded Soviet citizens.

Pilot Taranenko, delivering medicines to field hospitals, was attacked by Nazi fighters, while several wounded soldiers were with him. His plane was damaged by enemy fire. So, Taranenko landed—

One of the best Soviet fighters is this I-18. With a 1250 hp. liquid-cooled Mikouline engine, top speed is over 340. Armament includes a 20 mm. cannon and six machine guns.



An Ilyushin bomber, the prototype of which made the Moscow-New York flight in April, 1939. The extensive civil aviation program in Russia prepared thousands of men for war duty on ships like these. Called the DB-3a, it carries 4,400 lb. at 265 m.p.h.

and it was not on an emergency field either—effected repairs and flew the wounded to a hospital.

The foregoing incidents afford but a brief cross-section of the Soviet civil ambulance service. As the war continues, this invaluable collaborator with the Red Army Medical Corps will continue to set and break its own records for the extent, elaborateness and daring of its work.

Nor has the expansion in medical work interfered in the regular airline operations. Since the beginning of the war the Civil Air Fleet has been striving to maintain the record set last year when it placed the USSR in the first place in the world in the total mileage of regular routes.

Until that fateful night of June 22 when the Wehrmacht lunged across the Soviet frontiers without a warning, the transport of passengers, mail and express was steadily growing in importance in the USSR, ably complementing corresponding rail and waterway facilities. By 1940, Soviet airlines totalled 88,000 miles, compared with 36,581 miles in the United States. If we included the foreign lines operated by the two countries at that time, the figures are, respectively, 93,000 and 80,109 miles. The U.S. led in the number of passengers carried and although in this respect the Soviet Union was left considerably behind, it in turn was far ahead of the rest of the field. The Soviet lines transported 307,000 passengers in 1939, by far the highest figure for any European power, but U.S. lines accounted for 1,876,000 air travellers that year.

But the USSR led with mail transport when it reported 11,517 tons in 1939. It is also world leader in air freight haulage. In 1939, the last pre-war year, it shipped by air 39,654 tons of freight as against 4,757 tons carried in the U.S.

However, Soviet air travellers are fully appreciative of the advantages of their country's airlines. They know that the railroad trip from Moscow to Alma-Ata, to give only one example, requires five days, but the 2,235 mile beeline is traversed by the airliner in less than 15 hours.

Moscow is the great focal point for air transport. Regularly and frequently the liners take off for or arrive from Leningrad, Ashkhabad, Tblisi, Mineralniye Vodi and other European and Asiatic cities of the Union. Some schedules have had to be drastically revised or eliminated; for instance, the German occupation of Kiev caused the discontinuance of one of the most popular air routes, that between the Russian and Ukrainian capitals. Since in nearly every case of Soviet evacuation, valuable equipment is removed in good time by the defenders, airplanes on the Kiev route and others undoubtedly have been transferred to increase the service elsewhere.

Incidentally, the run on the Moscow-Mineralniye Vodi route is by the six-engined USSR-L-760, the successor to the giant Maxim Gorki type. The L-760 has a range of 3,000 kilometers (1,875 miles) and accommodations for 64 passengers and a crew of eight, as this writer reported in the pages of AVIATION last year. Recent cables from Europe have told of its conversion into a heavy bomber. The weight of this ship in flight is 45 tons; wing spread 210 ft., height 23 ft.

Other aircraft types widely used for mail and passenger traffic include PS-84, PS-40, PS-35 and others. Whereas in the past speed and comfort used to be sacrificed for sturdiness, durability and carrying capacity, today these ships compare with the best in the world. On the Moscow-Irkutsk line, 2,835 air miles long, a 20-hour schedule is maintained. At the beginning of 1941 the 11-passenger PS-35s averaged 250 m.p.h. rate on some runs. On heavily patronized runs this plane is augmented by another twin-engined ship, PS-84 which takes aloft 21 passengers. Used on the Moscow-Stockholm line, this plane cruised at 170 m.p.h., though there have been hints from the pilots that they used it quite regularly at 190 m.p.h.; maximum speed is, of course, higher. Resembling America's DC-3 (which, incidentally, has been basic equipment on most of the Soviet international lines), the PS-84 has 1,250-mile range and 18,000-foot ceiling. It takes off at 80 m.p.h., lands at 85 or lower, handles easily, flies on one engine with which it maintains 95 m.p.h. Its adaptability to complex air and ground conditions led to its introduction in 1941 on the Arctic airways, of which more presently.

Also widely employed in commercial flying is the Stal-11 which has several versions. Particularly well streamlined, this was first built in 1936 when a Hispano-Suiza engine powered it, later to be replaced by a liquid-cooled native power plant. In 1939 the seven-passenger model of Stal set the present world speed record for non-military planes, when it covered 5,000 kilometers (3,100 miles) non-stop at 251 m.p.h.

Prior to the war a number of international airlines operated under the auspices of the Main Administration of the Civil Air Fleet. They linked the country with Berlin, Stockholm, Sofia, Kabul and other centers of Europe, Asia and Near East.

On those, as well as on the domestic lines, a great many pilots and flight mechanics were known as "millionaires"; each had to his credit at least 1,000,000 kilometers in the air. The quality of their training has made it possible in recent years to take advantage of the latest technological advances made by aeronautical research in the USSR and abroad. On the initiative of some veteran pilots and with the cooperation of engineers and other technicians, civil aircraft have been built to operate normally at altitudes of 13,000 to 19,000 ft. These heights endow the planes with greater speed and result in a substantial conservation of fuel. The utilization of such norms has made possible, among other things, mail from Irkutsk to Moscow in less than a day.

(Turn to page 184)

Soviet planes have been flying into the far north for years. This biplane was attached to an ice-breaker which rescued the famous Papanin quartet from an ice floe after the men had spent two years studying polar conditions.

all pictures from Sovfoto

British Bomber Crews In Training

The R.A.F. puts its bomber crews through an exacting course of study where synchronized team work is developed.

By an R.A.F. Officer

This article was written by an R.A.F. officer whose name must be witheld. It was flown across the North Atlantic by a British ferry ship. Drawings are by the distinguished artist A. Leydenfrost.

AT the beginning of the year the first few officers and airmen arrived at the new aerodrome to camp in huts islanded in a wintry sea of mud. The soil here is almost clay, lying thick and heavy in this flat space between limestone hills, a blanket which keeps down the lime and encourages bracken and pine-trees, an alien growth in the Cotswolds.

Now, on a rainy day in summer, there are still sticky patches of uncovered earth, but lawns and flowerbeds are beginning to spread. In front of station headquarters there is a very tidy garden. "You should have seen those dahlias a week ago," the visitor is told—"all raised from seed, of course." There'll always be an England, even if most of it has to be cut up into aerodromes.

The dahlias are the most obvious sign of swift and efficient organization, and one about which it is permissible to boast—to flower so soon they must have been raised in heat. But everywhere else there has been as quick a growth.

In raw and unimpressive sheds there are all the extraordinary machines and devices which teach bomber crews to fly, to navigate, to shoot, and to bomb. Some of the machines are incomprehensible to anyone but an expert. Other devices have a simple and even innocent ingenuity which is almost as remarkable. On what appears to be a kitchen table, though tilted at an angle of 45 degrees, a warrant officer crouches. By his side is a board covered with switches. Behind him stands a sergeant who is allowed only a little wooden handle on his board. The first is the bomb-aimer, the second the pilot.

In dramatic accents the bomb-aimer announces: "We are crossing the English coast, and now is the time for the bombs to be fused." He presses a little switch by his side, but nothing really happens.

A few seconds later he continues, "We are nearing the target. We are going to drop the whole load in one stick. It's a big target, Krupp's works at Essen, so we put the bombs well apart, 70 yards between each. I arrange the selector switches on my Mickey Mouse." He arranges them, and then the drama heightens, as he tells the pilot how to approach Krupps.

"Bomb doors open!"

"Bomb doors open," the pilot answers.

"Right. Right. Left. Steady," and again the pilot repeats the words. Then down goes another switch.

"Bombs gone!" exclaim both bomb-aimer and pilot.

With a shocking thud, alarming after so much dramatic preparation, three rows of little wooden bombs, each bomb very carefully carpentered and painted to look like the real thing, flop down from a wooden frame-work to a green mattress three feet below. Even more disconcerting and wholly unexpected is the release of a sheaf of long wooden incendiaries from a metal box beside them. They fall with a crash to the hard floor at one's feet. It will take some time to pick up all the bombs and fit them on to their hooks, but by the time the apprentice bomb-aimer has repeated again and again the actions and words of the warrant officer he will know all his switches forwards and backwards.

British Press Service

Training of bomber crews never ends in the R.A.F. This photograph was taken at the dramatic moment just before bomber crews go to their planes to raid Germany. The Wing Commander, in shirt sleeves, has given his final instructions. Now the Station Intelligence Officer is giving his word of advice as pilots and navigators take a last look at the maps. Sound training and efficient teamwork pay big dividends.

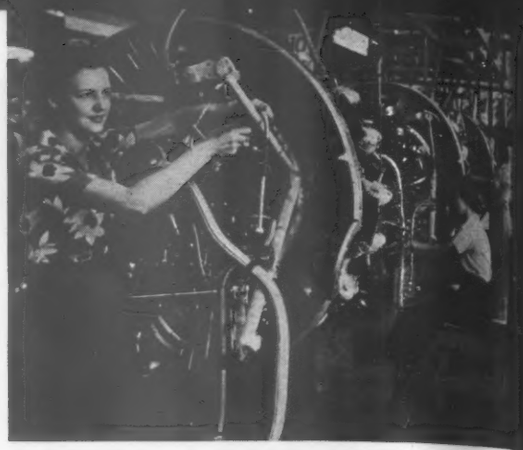
Bomber crews practice in dummy cockpits, like this one, as searchlights blaze into their eyes and strong lights flash off and on. Loud noises add a further touch of realism as crews learn to work together.

In R.A.F. training stations bomber crews work together on a high balcony. On a white floor beneath is projected a moving panorama of German countryside, giving the crew an illusion of traveling high and very fast. The instructor selects a target and immediately the bombardier adjusts his bombsight and gives the word to bomb. A white spotlight informs the crew if it has made a hit.

But the bomb-aimer must do more than manage a key-board of switches. He learns to aim his bombs in a building which looks as if it had strayed from Greenwich observatory — this school for bombers does not seem to have made up its mind whether it is a kindergarten with equipment for the Montessori method of teaching, or a laboratory for advanced research in physics. This building is called the A.M.L. (Air Ministry Laboratory) Teacher. It is a very tall room, pitch dark when the door is shut, with black walls and a white floor. Eight feet or so up one wall there is a balcony and many elaborate instruments; one of these, rather like an abacus, with strings and beads—the kindergarten again—projects outwards over the floor. Then a brilliant light goes on at the very top of the room and the concrete floor shines upwards, but now it is marked with an irregular pattern of grey smudges. The pattern begins to move and then reveals itself as a grey landscape, sliding away fast and very far below. The illusion is admirable; now it is the balcony which appears to be moving and to be, in fact, the cockpit of a bomber, racing through the air over a twilit landscape. The instructor chooses a target on the ground, with some dry military joke about Berchtes-

(*Turn to page 140*)

Women at Vultee work all through the factory, even in the machine shop. In the foreground women are running milling machines.



In engine assembly girls work on carburetors, manifolds, air heaters, ignition harnesses and other parts.

They Wear The Pants

Vultee Aircraft has called in women to help relieve the employment shortage.

By W. Gerard Tuttle *Industrial Relations Director, Vultee Aircraft, Inc.*

WAY last April, long before Sidney Hillman asked the aircraft industry to tap the reservoir of women workers, we had started hiring women at Vultee. In the six months since then we have employed more than 300 women and have put them to work throughout the factory, including some on light riveting. We have learned some interesting things about the place of women in the aircraft manufacturing industry. And we have lost much of our fear of a shortage of man power which might result as the defense program expands.

We did not turn to the employment of women last April through any lack of men workers at that time, although a shortage of male workers has since begun to develop. It is true that we wanted to anticipate any labor shortage by experimenting with women workers, but there were a number of additional reasons for their employment. Women have long been active in almost every branch of American industry including many of the manufacturing industries, but they had made little progress in aviation work. We did not see why they could not be used to advantage in many departments in addition to their traditional work in fabric trimming and sewing. The women themselves have been placing aircraft factories under continuous pressure to employ them as a means of permitting their fuller contribution to the national defense program. Furthermore, as aircraft have grown more complex, a multitude of intricate assembly operations have developed. These require considerable finger dexterity and

W. Gerard Tuttle

On balconies overlooking the Vultee main assembly floor girls install cables in master junction boxes and do other sub-assembly jobs.

Various small parts are placed on conveyors in the paint department, are spray painted, then dried by ultra-violet ray lamps.

it was believed that nimble female fingers would be ideal for such work. Finally, up-grading of the men workers to advance them to more important work is a vital phase of current aircraft building. It was felt that the men could be advanced more rapidly to the more responsible jobs if women could take over the simpler, repetitive operations.

All of the reasons which induced us to experiment with women workers throughout the plant, including welding, riveting, machine shop work and final assembly operations, have been proved sound in practice. Women have not displaced men but have simply freed them for more rapid advancement than would otherwise have been possible. The women are paid the same wage scale as the men for the same work. The result is that the women are well pleased with their pay, which averages considerably more than they had earned elsewhere. And hands which have long been accustomed to monotonous manipulation of knitting needles or crochet hooks have proved more patient on routine work than those of the average man.

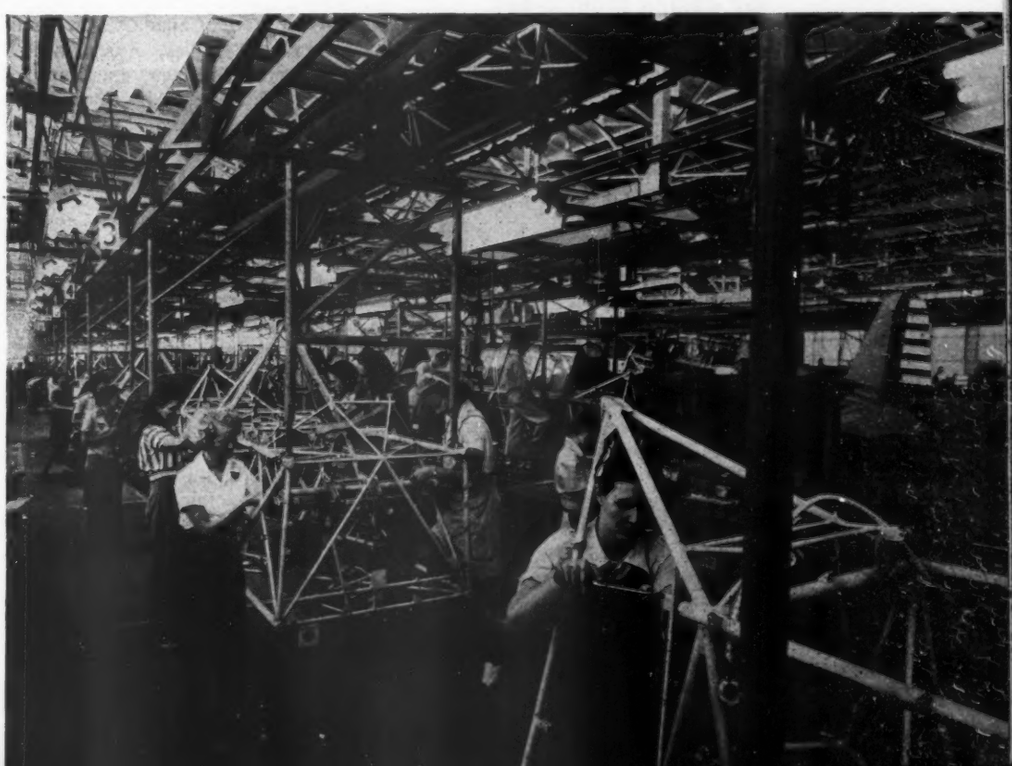
Hiring and training of women workers has not been the problem we feared. Almost 90 percent of our women workers have had previous experience in other manufacturing work. Such work has covered a broad scale, including especially radio and phonograph manufacture, can machine operation, plastics manufacturing and miscellaneous small machine operations. But this experience has accustomed the women to factory discipline and made it easy to fit them into the schedule along with the men. So far there is every evidence of the availability of as many women workers as we may need for many months to come. We have made a careful study of operations in our plant which could be performed to advantage by women and believe that at least half of all our work could be done by the girls without sacrificing efficiency. In an emergency we might find it possible to approach the figure of 80 percent of women workers reported by some British factories.

Training Women

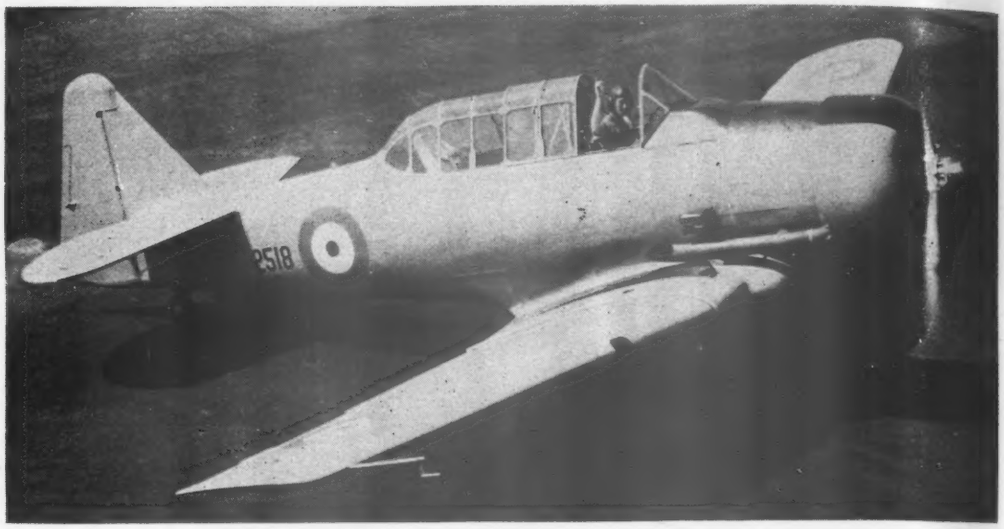
We did not find the training problem difficult. Because of prior mechanical experience most of our women have stepped into their new work with ease. Since most of our operations are greatly simplified under the quantity production schedules now being followed, it has been satisfactory to put the women right into the shop without any formal pre-employment training. They are instructed on the job by the foreman in charge. In practically all cases a period of from two hours to a single eight hour shift is long enough to spend in training a new woman worker for

(*Turn to page* 182)

This girl sits on the floor as she installs control cables on a basic trainer.



Women work on the mechanized assembly line installing brackets, controls, seats, canopies and many other small parts.



A Royal Canadian Air Force pilot about to take off in a North American Harvard trainer.

Canada Trains The Empire's Warbirds

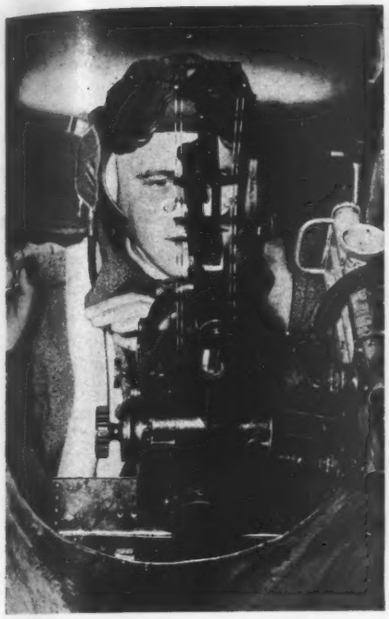
At 100 fields throughout Canada thousands of pilots and technicians are being trained. The training plan is 18 months ahead of schedule and 25 squadrons are already overseas flying for the Empire.

By James Montagnes

IN December 1939 Canada's Prime Minister Mackenzie King announced that the British Empire's airmen would be trained under a joint plan in Canada under Royal Canadian Air Force supervision. When the second anniversary of that momentous announcement rolls around Canada can announce that the Commonwealth Air Training Plan is in full swing, that more schools are in operation than were originally planned, that an instructional and ground staff of more than 46,000 is functioning, that nearly 72,000 officers and men are in the Royal Canadian Air Force, that the plan is some 18 months ahead of schedule, that thousands of pilots, gunners and observers are being trained monthly. In fact so well has the Plan worked out that there is now talk in Ottawa that the capacity of the Plan may be doubled with Canada taking on the full responsibility of training Great Britain's airmen as well as those of Canada, Newfoundland, the West Indies, Australia and New Zealand. Thirteen squadrons of the Royal Canadian Air Force were reported to be flying over Britain by mid-September, 1941. Establishment of 25 squadrons overseas was on the books for the end of 1941.

The tempo of the Commonwealth Air Training Plan has been greatly accelerated since its announcement. Announced to cost $600,000,000 during the three year term till April 1943, the cost has now been set near the $1,000,000,000 mark for that period. Planned to be in full production sometime in 1942, it is now functioning with more schools and airfields than originally planned, and requiring the completion of only a few schools to bring the total to 91 schools and 100 flying fields. Training has also been speeded up and pilots now come off the production line in 22 weeks, bomber-observers in 27 weeks, and wireless operator-gunners in 24 weeks. Advanced training in actual combat planes is given overseas as a finisher before graduates of the Commonwealth Air Training Plan take their places in fighter and bomber aircraft for operations in the various war zones.

Starting from scratch, with only the peacetime Royal Canadian Air Force of less than 3,500 officers and men as a nucleus, the Commonwealth Air Training Plan has come a long way. Great Britain sent over a small force of air force specialists to help organize the Plan, sent over some planes and engines as part of its share of the cost. Throughout Canada elementary and advanced flying schools were started, using the government-sponsored light flying clubs as a base for elementary training and private companies consisting mainly of small transport and school operators as a base for intermediate training. Royal Canadian Air Force schools were widely scattered throughout the Dominion for advanced



Bombardiers lie flat as they peer into a bombsight during instruction periods. This view was taken from beneath a plane.

Small models are used in gunnery exercises. The striped model is towing a target while the small white plane is shooting at the moving target and the stationary target on the ground at the right. The white lines are methods of flying for fighters.

flying, bombing and gunnery training, wireless operating, administrative and ground crew instruction. Civilians were used for much of the instructional work for both flying and ground crews. As the Royal Canadian Air Force expanded numerous of these civilian companies were disbanded or made a part of the air force.

Because Canada's aircraft industry in all its branches was small, many civilian pilots and mechanics were recruited in the United States. From south of the Canada-U. S. A. border have also come many recruits for the Royal Canadian Air Force, mostly pilots of experience and youths anxious to fly. It was stated recently by J. T. Thorson, Minister of National War Services in the Canadian Cabinet, that eight percent of all air crews being trained under the Plan are Americans, and that there are about 600 American instructors in the air training schools. Those in the Royal Canadian Air Force are distinguished by the wearing of a shoulder badge with the letters U. S. A. embroidered on black. The Americans come from all parts of the country, from all walks of life. Canadians make up the bulk of the air force, with a smattering from many parts of the Empire and the Latin-American republics. Australians and New Zealanders, the former easily distinguishable by their darker blue uniforms, make up about 15 percent of all the trainees under the Plan.

There are now 17 recruiting centers throughout the Dominion. On passing the medical examination and meeting all other requirements, recruits are sent to 6 manning depots where they receive elementary air force drill, are outfitted, given inoculations against typhoid, tetanus and smallpox, are sorted into ground and air crew. If picked for air crew they wear a white strip in their caps. Those picked for pilots or bomber observers go to 7 initial training schools, to receive instruction in mathematics, armament, instrument flying in Link trainers. They are watched by medicos and psychiatrists, put through many tests to check their ability to stand high altitude flying, their alertness, adaptability and initiative. After five weeks they are sorted out as to pilot and observer material. Meanwhile those who will become gunners and wireless operators have started their training in one of 4 wireless schools.

The pilots go to one of 26 elementary flying schools where they learn in 7 weeks to fly in Fleet Finch and de Havilland Moth trainers. If successful they will have done 25 hours solo flying at the end of this training period. Now comes 10 weeks at one of 16 service flying schools, to learn advanced flying, aerobatics and night flying in

(*Turn to page* 160)

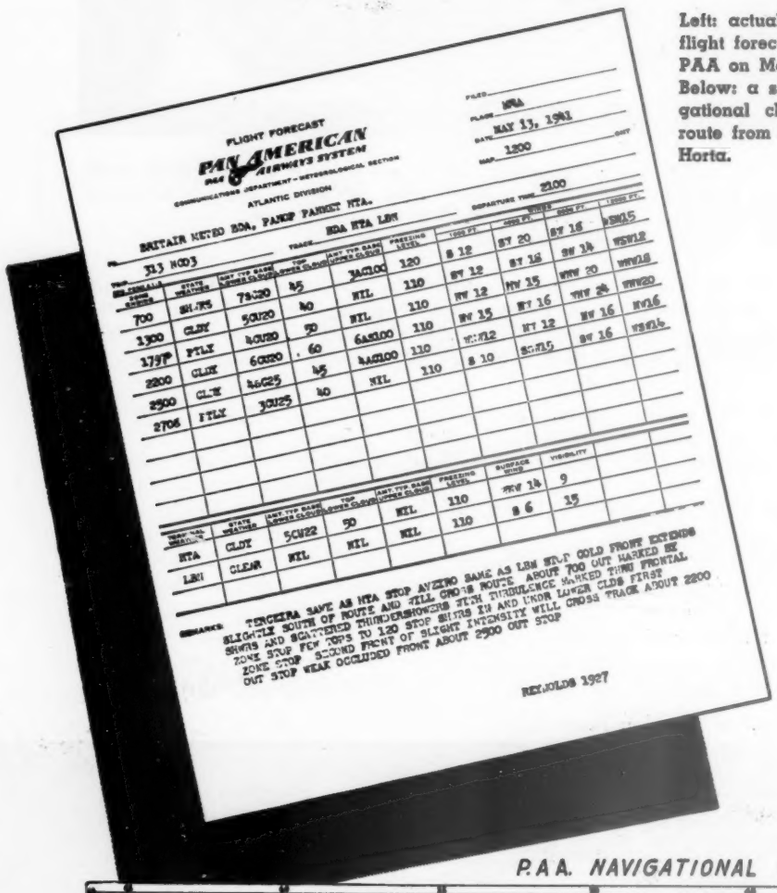
All photographs from Royal Canadian Air Force

Right: mechanics servicing a Harvard trainer at the Ottawa flying school.

Scientific Control of

This article, covering the technical phases of trans-Atlantic flight operations, is the second of three on Pan American operating policies.

By John C. Leslie, *Manager, Atlantic Division, Pan American Airways System*



FLIGHT FORECAST

PAN AMERICAN AIRWAYS SYSTEM

COMMUNICATIONS DEPARTMENT—METEOROLOGICAL SECTION

ATLANTIC DIVISION

FILED _____ PLANE NRA DATE MAY 13, 1941 MAP 1200 ____ GMT

BRITAIN KEYED BDA, PARIP PARKET NTA.

TRACK BDA NTA LSH DEPARTURE TIME 2100

TIME	STATE WEATHER	CLOUDS BELOW	TOP	CLOUDS ABOVE	FREEZING LEVEL	LOW FT.	MOD FT.	SURFACE WINDS 6000 FT.	12000 FT.
700	BR.PS	7000	40	24M100	120	S 12	SW 20	SW 18	WSW15
1300	CLDY	5000	50	NIL	110	SW 12	SW 18	SW 18	WSW12
1755	PTLY	8000	50	NIL	110	SW 12	NW 25	WNW 20	WNW18
2200	CLDY	6000	60	64M100	110	SW 15	SW 16	WNW 24	WNW20
2500	CLDY	4000	45	44M100	110	W:M12	SW 12	SW 16	NW16
2706	PTLY	3000	40	NIL	110	S 10	SW:M15	SW 16	WSW16

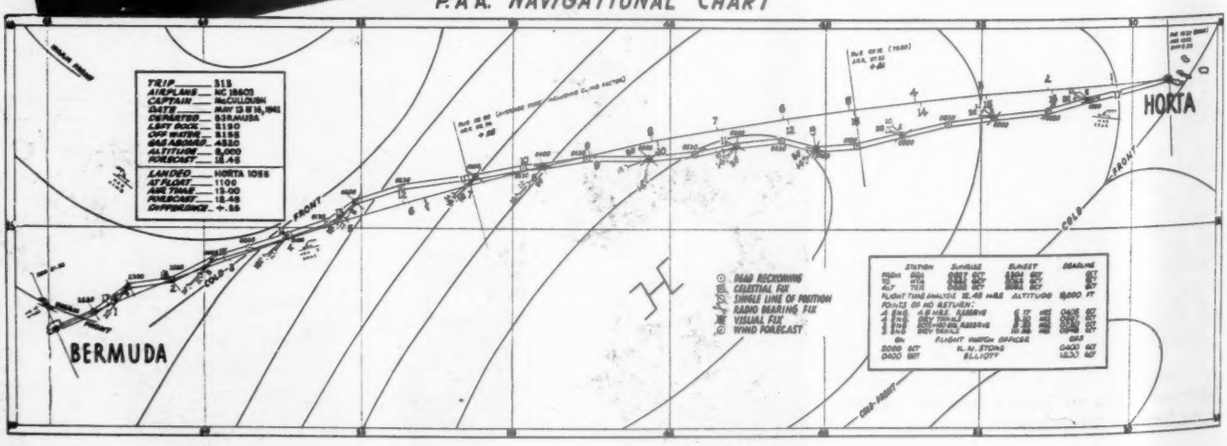
	STATE WEATHER	CLOUDS BELOW	TOP	CLOUDS ABOVE	FREEZING LEVEL	SURFACE WINDS	VISIBILITY	
NTA	CLDY	5000	50	NIL	110	NW 14	9	
LSH	CLEAR	NIL	NIL	NIL	110	S 6	15	

REMARKS: TENCEIRA SAME AS NTA STOP AVZERO SAME AS LSH STOP COLD FRONT EXTENDS SLIGHTLY SOUTH OF ROUTE AND WILL CROSS ROUTE ABOUT 700 OUT MARKED BY SHOWS AND SCATTERED THUNDERSHOWERS STOP TURBULENCE MARKED THRU FRONTAL ZONE STOP FEW TOPS TO 120 STOP SLIGHT INTENSITY ICING ZONE STOP SECOND FRONT OF SLIGHT INTENSITY WILL CROSS TRACK ABOUT 2200 OUT STOP WEAK OCCLUDED FRONT ABOUT 2900 OUT STOP

REYNOLDS 1927

Left: actual copy of a flight forecast used by PAA on May 13, 1941. Below: a sample navigational chart of the route from Bermuda to Horta.

P.A.A. NAVIGATIONAL CHART



DURING the eight years which preceded the inauguration of trans-pacific Clipper passenger service, Pan American Airways' pioneering in the field of over-water air transport dealt with one basic objective: safe, non-stop flight over long reaches of open ocean. Pan American technicians devoted all their skill and energy to the development of equipment and techniques by which transocean flight assignments could be executed with an adequate assurance of safety. In the last analysis, that is still the underlying problem and it will vanish only when ocean airliners can operate through any weather, at any time, and over any distance, not only with absolute safety, but with precise regularity and punctuality.

During the last five years, however, Pan American engineers have been working also with a group of problems which constitute a frontier of effort more sophisticated than that of simply maintaining a safe service. These problems may best be grouped under the title, "The Economics of Fuel Economy."

Fuel economy is undeniably important in any type of transport flying. In domestic operation fuel costs represent approximately ten percent of all operating expenditures. A one-percent reduction of specific fuel consumption

Transocean Flight

for the typical engine used in such flying would result in a total saving to the domestic air transport industry of many thousands of dollars per year. But the fact that the fuel load of the average domestic transport plane could be reduced by one-percent would have small effect upon its ordinary payload capacity. On a New York to Chicago nonstop flight, for example, a one-percent reduction of the typical fuel load would amount to only 27 lb.

In the economy of a transatlantic or transpacific airway, however, the difference of a few percent in the amount of fuel required makes literally all the difference between a commercially practical operation or no airline at all. When you are loading as many as 5,000 gallons on a plane for takeoff (i.e., a fuel load of 30,000 lb.) a one-percent saving of fuel means certainly a finite reduction in the airline's fuel bill. But that is a comparatively minor consideration. Saving one-percent in fuel weight means saving 300 lb. which can be devoted to passenger or express payload. When it is considered that the weight allowance made for a transatlantic passenger and his baggage is only 242 lb., and that the transatlantic one-way fare is $525, it is easy to see why Pan American has minutely scrutinized every factor conceivably relating to fuel consumption.

More important, the refinements of Pan American's fuel consumption studies, now based upon experience with more than five hundred Pacific and four hundred Atlantic crossings, has actually been of very real national importance. Literally hundreds of additional passengers whose journeys were importantly connected with the nation's defense efforts have been able to make transocean crossings solely because Pan American had been able scientifically to control its flight operations.

John C. Leslie

Chief Engineer Andre Priester carries his plea for engine and propeller efficiency even to his Christmas cards. Here his three Wise Men lead a procession going to Hartford and Paterson carrying banners inscribed with Mr. Priester's hopes: engines with a specific fuel consumption of .36 and propellers with an 89 percent efficiency rating.

Various mathematical expressions have been used in the past to measure the efficiency of airplane flight. The basic factor in the economics of transocean fuel economy is more than "air miles flown per pound of fuel consumed." It is even something more than "ground miles made good per pound of fuel consumed." The real measure of effectiveness of a technique designed to realize the maximum benefits of flight control can only be measured in terms of "fuel loaded per crossing completed."

Such an index obviously brings in every element of the flight operation. The objective of any such technique is plainly to permit the dispatch of a plane with just enough fuel on board to permit the crossing to be made under the weather conditions which the flight will encounter, plus some adequate reserve. Only then can a maximum percentage of the plane's useful load be devoted to commercial purposes. For example, if the flight forecast for a given crossing turns out to have been unduly pessimistic, the plane lands at the end of its crossing with much more fuel than the specified reserve. The achievement of a better specific fuel consumption than anticipated has the same result. Yet it was the forecasted fuel consumption of the flight, not the fuel actually used, which determined the payload transported on that crossing.

Obviously, the ultimate limits of the fuel economies that can be effected on any airline operation are determined far back in the design stages of the aircraft, engines, and propellers with which the operation is conducted. The Pan American Airways System has, throughout its entire history, been vigorous in its efforts to cooperate with designers and manufacturers in the development of high-efficiency equipment. In many instances, Pan American has been the only—or at least the first—potential consumer for such equipment, although frequently developments undertaken primarily for Pan American purposes have later been widely used throughout transport and military aircraft.

In an airplane purchased for commercial long-range flight, several characteristics are essential. The first is an airframe which effects the best compromise between maximum L/D, structural weight, and flying qualities. The second is a power plant which produces uniformly reliable horsepower at consistently low rates of fuel consumption.

(*Turn to page* 188)

Aircraft Hydraulic Pumps

The second article in a series on aircraft hydraulic mechanisms.

By Lieut. Harry J. Marx, U.S.N.R.

In Charge of Hydraulics, Bureau of Aeronautics, Navy Department

and

Edward M. Greer *Hydraulic Engineer, Simmonds Aerocessories Co.*

DURING the past two years rapid strides have been made in the application of hydraulic actuating equipment in aircraft. The present defense program has accelerated the development of new types of airplanes and thereby an increased demand on hydraulic actuation. With the advent of these new airplane designs, the small group of hydraulic designers in this country have been called on to exert all their ingenuity in producing more efficient and lighter hydraulic components throughout the airplane, and they have met the challenge well.

It should be realized that although commercial airplanes have employed hydraulic actuating equipment on landing gear, wing flaps, brakes and the automatic pilot, there was no real extensive use of hydraulic mechanisms until the design of military aircraft reached its peak. Military airplanes call for greater speed and streamlining, necessitating that the landing gear be completely enclosed in the airplane during flight. This requirement resulted in the introduction of landing gear doors and their automatic operation with the main landing gear and nose or tail wheel. Speed of retraction of these components is another requirement. Bomb doors, bomb release mechanisms, gun turrets, all must be efficiently operated. New fighters carry a multiplicity of machine guns which are charged by hydraulic power and must meet specific conditions of speed and efficiency in charging. The new dive bombers with their diving flaps and tremendous loading characteristics but corresponding lack of space for actuating members were and still are a great problem to the hydraulic industry. The Navy torpedo bombers with their folding wings which must retract or extend into position under any weather condition have proven to be still another problem. In addition, airplanes now fly in the sub-stratosphere where temperatures of 67 degrees below zero are reached. Under these conditions the fluids now used in aircraft hydraulic systems become thick and sluggish and in many cases will not flow at all. Moreover, flying at these heights has introduced so many other problems in pump suction and material deterioration that a treatise on this subject alone will be written in AVIATION.

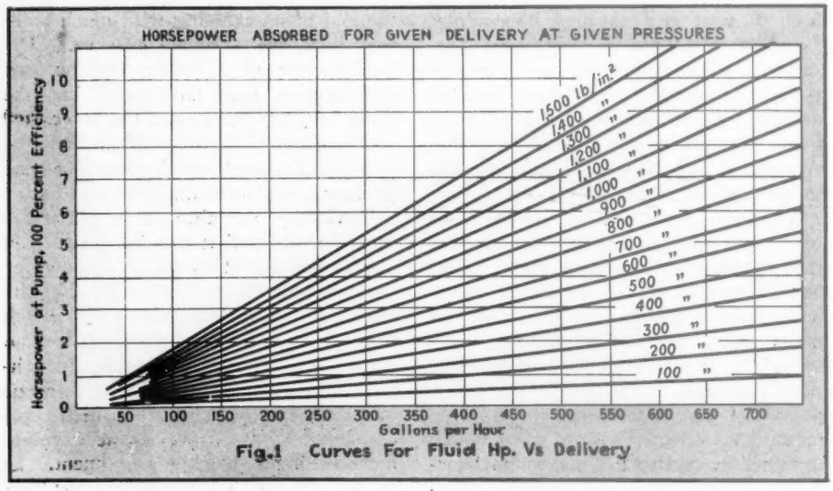


Fig.1 Curves For Fluid Hp. Vs Delivery

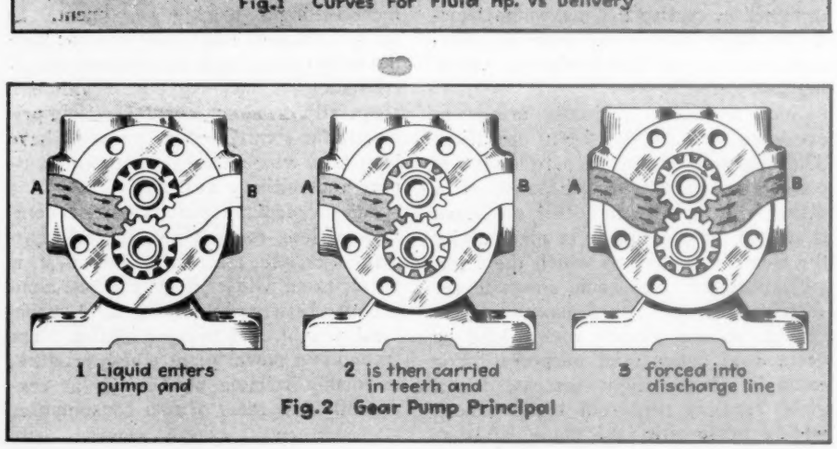


Fig.2 Gear Pump Principal

Opinions or statements contained in this article are personal to the authors and shall not be construed as reflecting the official views of the Bureau of Aeronautics.

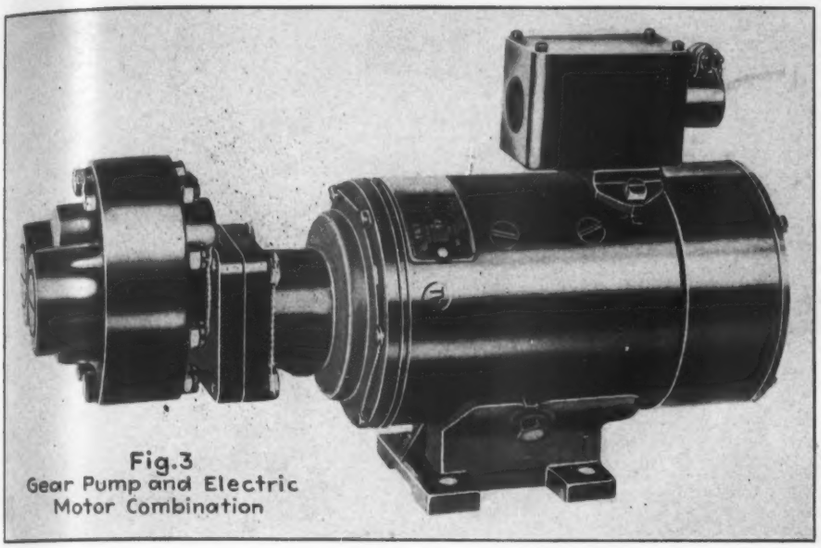


Fig.3
Gear Pump and Electric Motor Combination

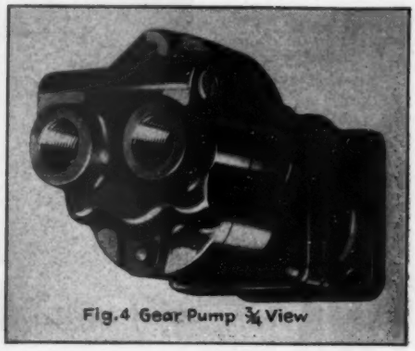


Fig.4 Gear Pump ¾ View

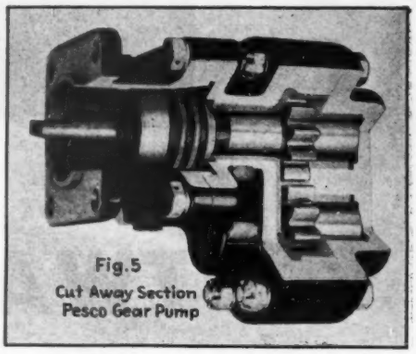


Fig.5
Cut Away Section Pesco Gear Pump

In general the aircraft hydraulic industry has been able to meet the new and increased demands made upon it. Multiplicity of actuating mechanisms merely called for complexity in the system with existing or refined valves and actuating cylinders. The American hydraulic designer solved the problem of sequence operation of the landing gear through doors and locks which are operated automatically by hydraulic mechanisms or by hydraulic and mechanical means. New valves to regulate timing and equalization of flow rate have been introduced. New fluids are now showing improved characteristics at low temperatures. Materials and packings are being developed, and great enthusiasm is felt about the ultimate solution of the high altitude problem.

Due to all these new developments, increasingly great demands have been made on the source of hydraulic power —the pump. For many years a single manufacturer of aircraft hydraulic pumps was able to supply the entire airplane industry with sufficient pumps to satisfy its needs. The gear pump, rather simple in design and quite small, weighing about 3½ pounds, with an output of three to four gallons per minute, and producing 1000 pounds per square inch pressure, was fairly well standardized throughout the industry. When increased demands were made on the pump, the same designs with larger output capacities at the same operating pressures were installed. In many cases with multiple engine airplanes, two pumps were introduced with a pump mounted directly on each of two engines.

(*Turn to page* 172)

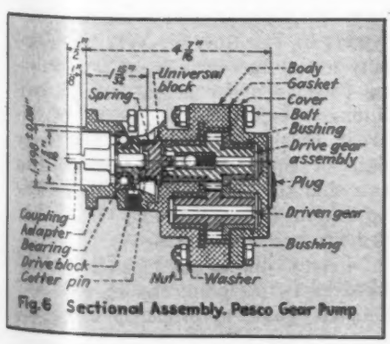


Fig.6 Sectional Assembly, Pesco Gear Pump

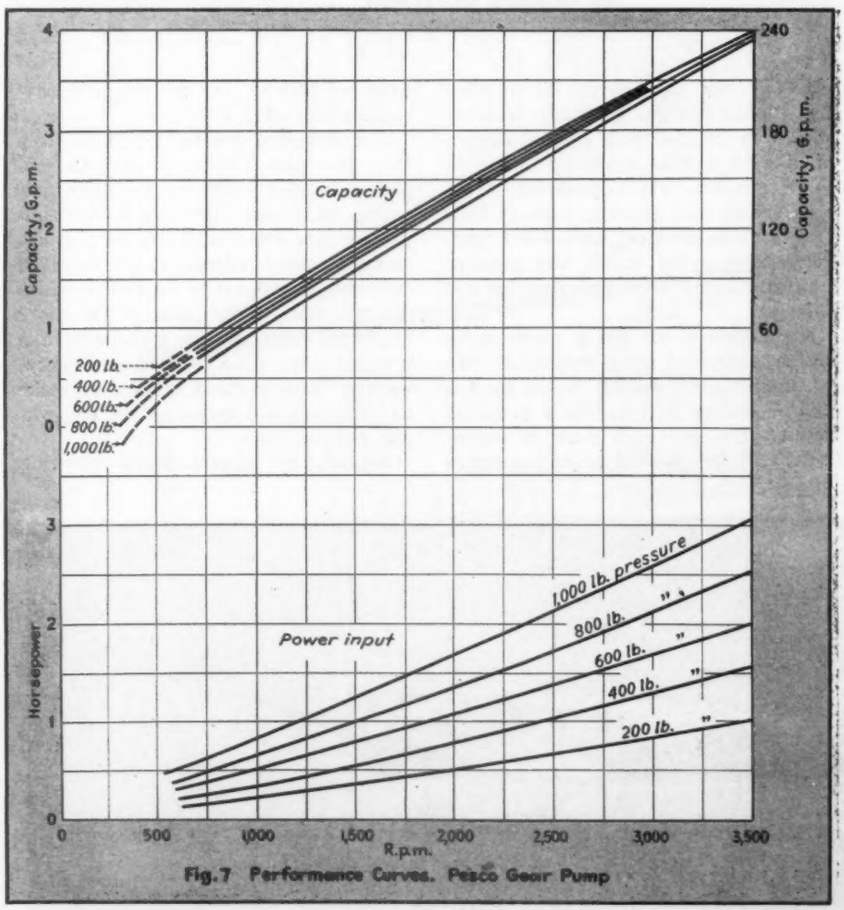


Fig.7 Performance Curves, Pesco Gear Pump

TWA Standardizes Paint

New painting chart guides base and terminal crews.

By William Maxfield, *Superintendent of Maintenance*

William Maxfield

WITH the completion of a color standardization program, which I believe to be the first ever attempted on a system-wide scale by a major U. S. airline, TWA propeller carts, wing stands and gasoline lines at New York will be identical with TWA propeller carts, wing stands and gasoline lines at Kansas City, Los Angeles and Chicago.

Not only will all TWA plane signs, hangar, shop and ramp equipment, offices, kitchens and waiting rooms be colored according to a carefully prepared identity-plan, but each piece of equipment will be painted with pre-tested finishes applied in the scientifically-correct manner.

We expect a number of gains from this new plan. First, a gain in employee morale: just as constant polishing of a warship's brass-work impresses care and cleanliness on a sailor, so does a rigid refinishing system teach care and cleanliness to an airline maintenance man. This point is far more important from a traffic standpoint than it might seem, for a chipped or sloppily-painted loading stand is sure to make an unfortunate impression on embarking passengers.

Second, we expect better painting work, for we have made the specifications as fool-proof as possible and have worked for many months with experts of The Sherwin-Williams Company to test and experiment with finishing systems under actual service conditions. Stocks of the scores of different finishes and colors for every piece of equipment are maintained at main and sub-bases, and can be quickly requisitioned so that no make-shift methods are ever necessary.

Then, too, the 42-page standards book prepared by the paint experts is a very complete guide to proper priming and

Booklet and sample pages illustrated here give complete specifications for all paint work on airplanes, ramp equipment, air conditioner trucks, and for interiors of shops, offices, rest rooms and kitchens.

Colors

painting. Instructions for finishing iron, galvanneal, dural, tin, copper, exterior wood, steel, stucco, brick and tile are all given in the book. Also finishing systems for both synthetic enamel and lacquer are provided in detail for planes and ramp equipment. A nine-step system for finishing cabin interiors is another feature.

Third, we expect better identity values and a clear-cut impression upon the passenger and potential passenger through the color-standardization of all our properties. In these days of color photography the constant repetition of the TWA colors on planes and airport properties cannot help but impress the TWA identity upon the public. These colors standards have even been carried to ticket offices, halls and rest rooms and other public rooms frequented by the travelling public, and while these interiors do not carry out the red, white and blue insignia colors, they are carefully planned to give a solid but completely modern appearance to all TWA interiors, thus reassuring the passenger through color psychology as well as that "planned" look.

Since the adoption of TWA color standards refinishing work has gone according to plan to our various bases and terminal stations. Naturally complete repainting of the entire station is not done immediately, but is made part of the regular maintenance schedule.

(*Turn to page* 168)

Giant hydraulic presses, equipped with Goodyear rubber press head, speed metal forming operations

Final inspection of completed tail units

SPECIFY GOO

Meeting the Need for more airplanes *now*, Goodyear Aircraft Corporation is fully mobilized and in action — turning out airplane subassemblies to supply production schedules of many leading manufacturers.

When the call came we were ready with veteran engineers of lifelong experience in aeronautical design . . . with master workmen highly skilled in the difficult art of light metal-alloy aircraft construction . . . and with facilities for fast production.

Today in our great aeronautical works, sheet metal parts are flowing in endless stream from giant presses to long lines of jigs—there to be assembled swiftly into wings, ailerons, nacelles, floats, tails and other surfaces for fighting aircraft.

Fully mobilized, too, is our production of tires, tubes, brakes and magnesium-alloy wheels, in greater volume than ever before. And of scores of rubber accessories.

Today Goodyear stands to aviation as it has long stood to the motorcar and truck industries—as the largest supplier of parts and accessories within its specialized field.

GOODYEAR

GOODYEAR AIRPLANE TIRES, TUBES, WHEELS AND BRAKES

A Procedure Control For Aircraft Welding

With thousands of new men being used as oxy-acetylene welders, it is necessary to rigidly control their work methods. Designers, however, may be primarily at fault if welding results are poor.

By A. K. Seemann, *Engineer, The Linde Air Products Company*

In any manufacturing industry, some method is needed that will bring about cooperation between design and production so that the product will unfailingly be what was expected in strength, durability and measurement. Such a method that has proved its value over and over again is known as a procedure control.

Oxy-acetylene welding is one of the most important fabricating processes in the aircraft industry. In order to develop the full advantage from this process, a procedure control that will bring the desired consistency of results is necessary.

In this article the important factors in a procedure control for oxy-acetylene welding are described in proper sequence. In addition, the fundamental principles of the oxy-acetylene process are given to provide the reader with an understanding of this method of construction.

THE essential elements in a procedure control for welding are:

1. Design for welding.
2. Selection and inspection of materials.
3. Establishment of a routine to give desired results in:
   a. Preparation of material
   b. The welding procedure
4. Qualification of the welding operator to follow the procedure.
5. Inspection and testing of completed work.

1. Design for Welding.

Oxy-acetylene welding is fundamentally simple. The edges of two pieces of metal are brought close together, heated to a molten state by means of the oxy-acetylene flame and, after an intermingling of the molten metal, allowed to cool down. Upon reaching room temperature there is but one piece of metal with, in effect, no joint at all. In practical application it is not as simple as that, but this fundamental simplicity does make it possible to produce excellent results with proper design and welding technique.

Joint design is usually considered as consisting of two parts. The first and perhaps simpler is the design of the weld cross section which will be discussed later under item 3 of the procedure control. The second is the design of the joining between two or more structural parts.

Design of Joinings Between Structural Parts.

Joint designs between two or more pieces of tubing are usually dictated by the final structure desired. There are certain basic designs, such as those between two pieces of tubing whose axes are to be in the same straight line or, in another case, perpendicular to each other. The Army, Navy, and C.A.B., singly or in combination, have formulated specifications (ANC-5, Strength of Aircraft Elements, Air Commerce Manual No. 18, etc.) regarding designs and materials covering these basic designs and it is not necessary to repeat them. Although there is not always complete accord with such specifications, investigation is continually in progress and undoubtedly they will be revised from time to time.

Aircraft designers are already familiar with necessary specifications. It is more to the point, therefore, if this article gives an explanation of the effect of welding on tubing and thus provides the designer with some material with which to reason.

Effect of Welding Heat on S.A.E. X4130.

Most tubing used in aircraft is purchased in the normalized condition which has been heated above critical temperature, soaked there a sufficiently long time to be certain the metal has reached a uniform temperature throughout, and then allowed to cool to room temperature in still air. Since X4130 is an air-hardening steel, such normalized tubing possesses higher strength and hardness and slightly lower ductility than if cooled slowly in a furnace.

During welding the edges to be joined are heated to a molten condition and allowed to cool in air. Because of the welding operation, in a relatively narrow zone adjacent to the weld there will be metal which was heated considerably above critical, just above critical, not quite up to critical, and only slightly heated. After welding, the hot metal will cool down more rapidly than if the whole tube was heated, since nearby cool metal will have a quenching effect. That gives three important effects to be considered, namely, expansion and contraction, air-hardening, and annealing.

Expansion and Contraction.

When a weld area is heated, the metal expands, and upon cooling contracts. Out of this come three factors of importance: possible distortion, locked-up stresses and, with X4130, whiteshortness.

Distortion.

Elimination of distortion is largely a function of the welding shop, but the designer must consider it in order to decide how completely he can expect it to be eliminated. During the years that aircraft tubing has been welded, welding shops have become particularly clever in eliminating distortion. Expected shrinkage has been estimated and proper allowances made. The designer must realize, however, that amounts of angular distortion and lateral distortion resulting from the last weld in a closed structure vary with the amount of heat the welding operator

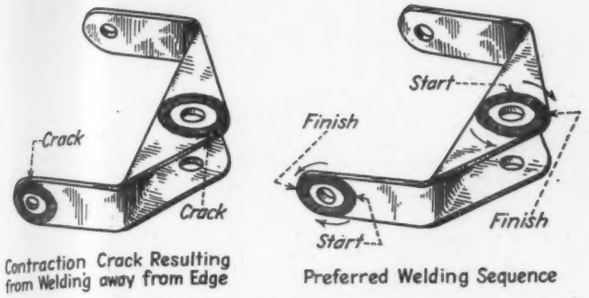


Fig. 1—Welds starting at an edge frequently develop a crack at the edge as shown in the sketch at left. Such cracks due to contraction stresses can be avoided by following the preferred welding sequence. Arrows indicate direction of welding.

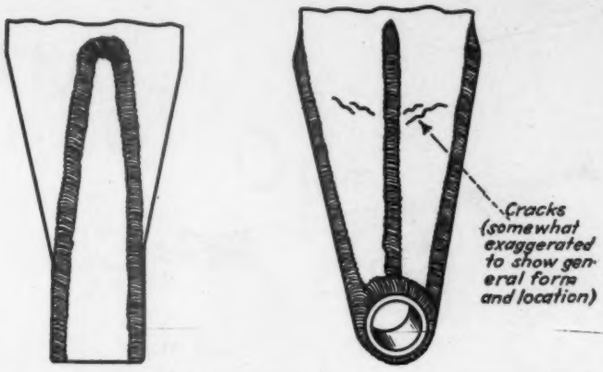


Fig. 2—Cracks like those shown are due to stresses locked-up during forming operations and released when the metal is softened during welding. The remedy is a preliminary heating of the stressed metal to a dull red.

uses. There is, therefore, a limit to the closeness of the tolerances to be expected. An instance which comes to mind illustrating a design calling for too small a tolerance, concerns the fabrication of a motor mount on which it was expected also to support a small oil tank. The welding shop was able to hold the face-to-face dimension of the mount to extremely close tolerance. Fixed brackets for the mounting of the oil tank added the requirement of keeping accurate angular alignment and straightness of the motor mount ring supporting tubes, and this caused considerable difficulty in the shop. A slight redesign to provide a small adjustment in the bracket would have met the condition with far less effort.

Locked-Up Stresses.

There are two sources of locked-up stresses. When cold-work, such as bending or flattening, is performed on tubing, stresses are locked-up in the metal. Practically all stresses caused by the manufacture of the tubing are relieved by the normalizing treatment.

During the contraction which follows welding, rather high stresses are locked-up in the metal which was heated. However, in static tension, compression, or torsion, these stresses do not cause any particular difficulty (provided there has not been any serious impairment of ductility), unless there be but little unstressed material adjacent to the weld. When a part is loaded, the internal stresses induced seem to continue to move about until all the metal which is available to carry load has been stressed to its yield point. Then permanent deformation begins.

For the designer this means that he should avoid placing welds too closely together. For instance, a short tube welded at both ends into a rigid structure cannot absorb a great deal of additional stress (in the same direction as those induced by welding). It becomes necessary for the designer to consider, therefore, where stresses induced by cold-work or by welding will be located, so that they may be distributed as uniformly as possible throughout the structure.

White-Shortness.

S.A.E. X4130 has the property of being white-short. It has extremely low strength at a white heat, above 2,000 deg. F. In general, care during the welding operation to avoid subjecting the white-hot metal to undue tension stress is sufficient. Frequently, however, the designer can avoid specifying a condition in which this property may become important. A small assembly with numerous welds in several directions, for instance, places a considerable burden on the welding shop to avoid distortion and locked-up stresses, as well as avoiding stress on any section that happens to be at a white heat.

Air-Hardening.

It was pointed out under the subject of locked-up stresses that the stresses locked-up in the weld do not cause particular difficulty provided there has not been an impairment of ductility. When a weld is made in cold tubing and the welding is performed too rapidly, the quenching effect of the cold metal in an air-hardening steel like X4130 may create a less ductile zone along the edge of the weld. The elimination of this, however, is definitely a function of the welding shop and not of the design department.

Annealing.

Somewhat the same situation exists regarding annealing as has just been described for air-hardening. A zone adjacent to the weld is heated below the critical point and then cooled, and naturally a certain amount of annealing takes place. This, however, is not serious and specifications for design take it into consideration.

In general, the factors which have been discussed are mutual problems of the design and the production departments. It is important, therefore, that the designer be acquainted with the welding problems in order that he may avoid them wherever a slight change in design is sufficient.

2. Selection and Inspection of Materials.

This includes base metal, welding rods, gases and apparatus. The affidavits of reputable manufacturers are acceptable for the first three items. Periodic inspection of apparatus should be performed.

Make it easy for the welding operator to get new blowpipe tips. The use of a bad tip may spoil the weld. More trouble from tips is experienced with bad welding technique.

3. Procedure Establishment Which Will Give Desired Results

It is here and in part 4 that a greater amount of effort should be expended. All too frequently the establishment of a procedure is left up to the welding foreman or a man who is considered a "good welder." When the welding has been completed, it is visually examined, checked for measurement, and usually tested by Magnaflux. From these points it is assumed that the part is what the designer expected.

In those shops in which a procedure control is used and which, consequently, are getting consistently good results, the line of attack is somewhat different. A conference is held over each new design. Estimates of the amount of allowance for expansion and contraction are made, the direction of welding is decided upon, as well as the starting and stopping points.

The parts entering the design are then prepared carefully to give a close fit, and welds are made in accordance with the plan. If the distortion is then within allowable limits the part is ready for testing. If the distortion is too great, the welding sequence is restudied and a new part welded.

Testing is done by more than just the Magnaflux process. The part is sub-

(*Turn to page* 144)

"THIS is no time to waste time!" is a theme recently adopted by the Air Transport Association to impress on the public the time-saving importance of flying. And who can tell for how long *speed*—of transport and production—may be vital to America's stake in civilization?

Fortunately, United States air lines are today the best in the world. They have made great strides in speed, safety and comfort. Air line passenger traffic has increased 300% in five years—totalling 2,727,820 in 1940. And, since 1929, fares per mile have been cut in half.

Defense, to which the air lines have contributed greatly, has necessarily slowed the progress of air transport. Nevertheless, planes are now in development which will carry more than 60 passengers each, and cruise with unprecedented fuel economy at speeds of approximately 300 miles per hour. They will fly regular schedules of 8½ hours between Los Angeles and New York.

"These planes," says President Jack Frye of TWA, "will give the United States leadership for years to come in air transport equipment. And lower costs, plus increasing demand for time-saving travel speed, will mean continued substantial development for the industry."

Ambitious, technically trained men will be needed, more than ever, for the operation and maintenance of the air lines.

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New Runways By Soil-Cement

Needing an airport in a hurry, Brewster Aeronautical becomes a "guinea pig" in a new construction method.

WITH a 500,000 sq. ft. factory under construction at Johnsville, Pa., destined to turn out increasing numbers of "Buffalo" fighters and "Bermuda" dive bombers for the British and the U. S. Navy, Brewster Aeronautical needed an airport, and needed it in a hurry.

There was no time to build one under ordinary construction methods—fighters and dive bombers would be rolling off the assembly line ready for testing before it was finished—and so Brewster was forced to become a "guinea pig" in a new method of airport construction, called "soil stabilization", as an alternative for concrete or macadam runways which take a year or more to build in ordinary airports.

Soil stabilization, which has been practiced in road building, is a comparatively quick and inexpensive system only lately coming into use in the building of airports, and consists of mixing small quantities of cement with the actual soil. Among several, there are two principal kinds of soil stabilization: cement and asphalt. These are used alternatively depending upon analysis of the soil in the area of the project; if the soil is predominantly sandy, cement stabilization is preferable; if predominantly a clay soil, asphalt is likely to be the most satisfactory. Some soils, as the shale type, will take either cement or asphalt stabilizations almost equally well.

Brewster discovered, in their case at Johnsville, that soil-cement runways, which had been used by the Army in building Westover Field, would require 15 percent by volume of Portland cement mixed with the soil which would afford a saving of more than 40 percent over the usual types of pavement. The runways, they were assured, would be good for ten years, and that, should it be necessary, additional surfacing would further prolong their life. Thus, Brewster could have an airport which would meet the CAB requirements for an A-2 rating and which would be satisfactory for the testing of warplanes.

The Hatboro site covers a 372 acre tract of land, and fortunately required comparatively little grading to lay out the runways, which are as follows:

After filling the runway troughs with fill from a "borrow pit", Portland cement was spotted in piles over the sand and gravel and later smoothed evenly over the surfaces.

Brewster Aeronautical's new Hatboro Airport, the runways of which were constructed in three months' time from the first bite of a bulldozer. Rapidly nearing completion, the Johnsville factory, right background, will soon be rolling out dive bombers and "Buffalo" fighters.

N.-W. runway, 2800 ft. paved and totalling 3000 ft. in length; N.E.-S.W. runway, 3000 ft. paved of a total length of 4600 ft., and E.-W. runway, 5100 ft. total length, 3000 ft. paved. All runways are banked and sloped and are 100 ft. in width. A distinctive feature of Brewster's new airport is that, as the ends of all runways can be seen from the ends of any one runway, no control tower will be necessary.

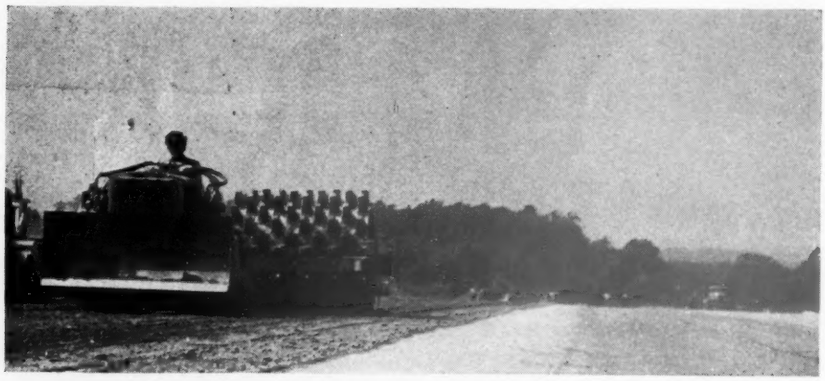
The first step in construction began with the removal of all topsoil. This was necessary, for the organic substances present in the topsoil would decompose and cause erosion ditches if mixed with the subsoil.

Next, a trough 100 ft. wide and six inches in depth was excavated between the exact lines of the runways. Upon analysis it was found that by using sand

(Turn to next page)

The runway troughs are filled with soil-cement to a depth of about six inches.

To protect the edges of the runways, a cinder fill is used which will later be rolled. Under this fill drainage pipes were installed along entire length of each runway to guard against unusual precipitation or sudden spring thaws.



Compaction of the mixture is accomplished by a "sheeps foot" power roller. This machine is fitted with closely-spaced square, tapered spikes which penetrate deeply into the soil, gradually packing it from the bottom up.

When the "sheeps foot" roller has packed the mixture to within an inch or so from the surface, the final loose mulch is rolled by a power roller.

and gravel from a "borrow pit" on the land, only ten percent by volume of cement, rather than the 15 percent originally planned for, was needed. The runways were therefore filled with seven to eight inches of this material.

After initially compacting and levelling, cement was spotted in piles over the fill which, after brushing evenly over the surface, was then mixed thoroughly with the soil by a battery of five rotary tillers. When the soil and cement were thoroughly mixed, a pressure distributor shot water from a bar sprayer into the mixture, and the rotary tillers followed, mixing the water with the soil-cement.

As no expansion joints are used when paving with soil-cement, work proceeded on a 24-hour basis in order to avoid a checkerboard appearance which would occur by allowing one portion to harden at a time. Batteries of portable floodlights were therefore employed and the illumination attracted hundreds of Bucks County people who came from miles around.

The soil-cement runways, instead of hardening as ordinary concrete, had to undergo a special process, compaction, by use of a "sheeps foot" roller which packed the mixture from the bottom up to the surface. If ordinary rollers had been used, only the first inch or two would have been pressed hard, leaving the subsoil unpacked. This would eventually settle, causing the runway to crack and break. The "sheeps foot" roller is equipped with closely spaced one-inch square tapered spikes which at first penetrate deeply into the mixture, packing the undersoil and gradually building up the compressed surface until only about an inch of loose mulch remains. This, when scraped by a patrol grader, is rolled by a power roller and finally by means of smooth-tired pneumatic rollers designed especially for the work.

Upon hardening, the surfaces of the runways appear like concrete and apparently as hard. The edges, however, must be protected by some means as they tend to crumble, and this Brewster did with cinders which were rolled even with the surface of the runway. It was also considered advisable to install drainage pipes along the entire length of each runway to guard against unusual precipitation and sudden thaws.

Thus it was that almost three months to the day from the time construction was first begun, the three runways for Brewster Aeronautical's new airport were completed, and the anticipated saving in money as well as in time had been entirely realized. Both airport and factory will be ready together, so that when the first dive bomber comes off the assembly line this fall, there will be an airport ready for its testing.

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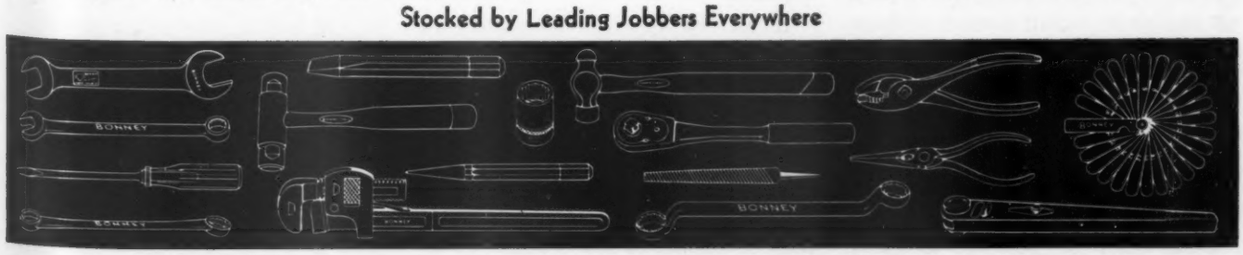


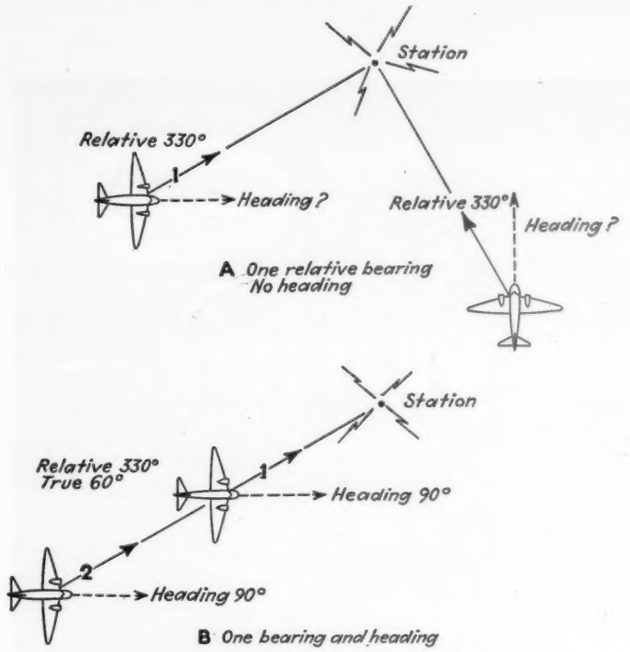


Fig.1 Insufficient Information for Fix

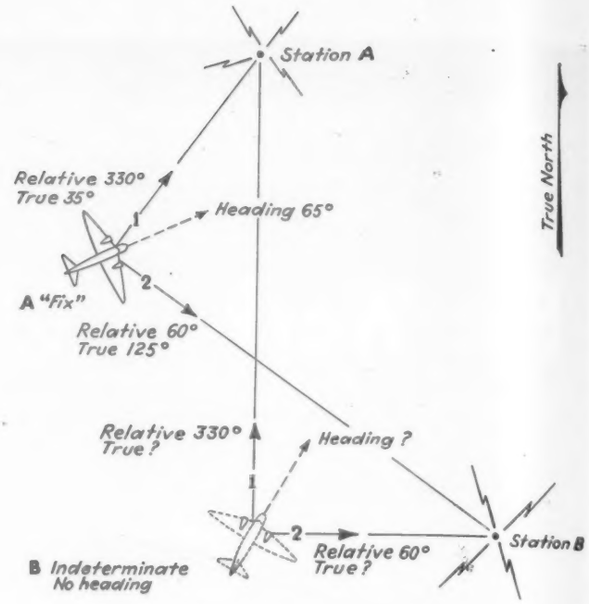


Fig.2 Two Bearings

Position Fixes By D/F Bearings

What every pilot should know about "fixes" and the proper use of the D/F Loop

By C. H. McIntosh

Instructor in Charge, Chicago Pilot Training School, American Airlines, Inc.

This concludes a series of three articles by Mr. McIntosh dealing with various problems relating to instrument navigation of aircraft. The first, Reducing Stacking Delays, was printed in the July, 1941 issue and the second, Navigation With The D/F Loop, appeared in the September issue of AVIATION.

STATED simply, a position "fix" as applied to aircraft consists of determining the position on the earth's surface above which the aircraft is flying at a specified time. Determination of such a fix, of course, may be accomplished by any one of several means other than radio bearings—such as by visual reference of ground objects, radio markers, intersections of radio beams or celestial lines of position. Likewise, definition of the position may be by any one of several means of reference—such as over a prominent landmark, by direction and distance from any easily specified place on the earth's surface, a recognized radio beam intersection, or latitude and longitude. By whatever means determined or defined, however, any fix denotes a definite geographic spot readily located on a suitable chart representing the earth's surface.

It will be apparent, then, that the fundamental prerequisite for obtaining a fix by radio (or other means) is sufficient information to locate the airplane in relation to the earth's surface. With standard receiving equipment (nondirective antenna) for radio range flying, this means a radio fix is possible only at the intersection of two beams, over a cone of silence, or low frequency "M" type marker. An ultra-high frequency marker receiver, of course, increases the fix possibilities by enabling use of the great number of fan and approach markers now in operation. Even so, it should be readily apparent that the inflexibility of the radio range system severely limits the availability of radio position fixes when only a non-directive receiving antenna is used.

The rotable direction finding loop provides the ideal means of obtaining a radio fix. Though its accuracy in this respect is not so good when mounted in an airplane as when on the ground, the flexibility of the aircraft loop, plus the fact that it is available for other purposes, outweighs this drawback. With the direction finder a pilot or navigator can at any time and from any position obtain a directional bearing on any radio transmitter which the receiver will pick up. Thus by a proper use of such bearings on one or more stations, the possibility of obtaining a fix is always present.

The direction finder offers two general methods for obtaining a fix. The first, for want of a better name, is termed an instantaneous fix. By this method bearings are taken on two or more radio stations as rapidly as possible. These are then converted from relative to geographic bearings for plotting on the chart. The intersection of two or more lines of bearing denotes the position.

The second general method of obtaining a fix with the direction finder is termed a running fix. In practice this is done by taking two or more bearings on either one station or two stations with a time interval elapsing between bearings. If only one station is used the angular change of bearing which takes place as the airplane moves in relation

to the station is combined with the distance the airplane moves between the bearings. By solving some type of triangle from this known information the distance and direction of the airplane from the station can be calculated. When two stations are used the first bearing taken is advanced in proportion to the airplane's movement between the time of the first and second bearings. This, in effect, simply advances the first line of bearing so that it is plotted as if taken at the same time as the second bearing.

Basic Requirements for Instantaneous Fix

As previously stated, the prerequisite to obtain a fix is sufficient information to locate the airplane with respect to the earth's surface at a definite time. Such a conception means, then, that any bearing taken with the aircraft direction finder must in some manner be converted from a relative to a geographic bearing (either true or magnetic). This is necessary so that the line of bearing can be plotted on the chart. This is shown by Fig. 1A which illustrates how a relative bearing alone fails to establish a line of bearing to the station. Fig. 1B shows this relative bearing converted to a true bearing by combining it with the airplane's true heading. In this case, the airplane is placed on a line of bearing of 60 degrees toward the station. It will be apparent, however, that insufficient information is available to fix the airplane's distance from the station.

Fig. 2A illustrates the minimum requirements for a position fix. These are two geographic bearings. As usually obtained in practice, this amounts to taking in rapid succession two relative bearings which when combined with the airplane's heading, automatically become two geographic bearings. Fig. 2B is shown to emphasize why the airplane's heading must be known. Since the bearings as read from the azimuth dial are always relative bearings, the airplane's heading must be known to properly orientate these geographically on a chart.

Restated in other terms, two intersecting lines of geographical bearing on separate radio stations are the minimum requirements for an instantaneous fix. In practice, this minimum requirement is satisfied by two relative bearings plus the airplane's heading. The mean time of the bearings is used as the time of the fix.

Since it is essential that the airplane's heading be known to enable conversion of relative bearings as read from the loop azimuth scale into geographic bearings, it should be emphasized that an accurate magnetic compass becomes as much a requirement for a radio fix as the direction finder itself.

One exception does exist, however, by which it is possible to obtain a fix when the heading is unknown. Such a condition might arise in practice, if for one reason or another, the magnetic compass has failed. Then three relative bearings taken in rapid succession on three different radio stations will usually provide a fix. The plotting of such a fix becomes much simpler with a three-armed protractor of the type shown in Fig. 3 than by other plotting systems. This will be discussed in detail in a later paragraph.

Practical Combinations for Fix

As previously stated, the minimum requirements for an instantaneous position fix are two intersecting lines of geographic bearing taken as near simultaneously as possible on separate radio stations.

This condition may be met as previously illustrated by Fig. 2. Two relative bearings will be taken in rapid succession on different radio stations. Combined with a known heading which has been flown during the shots, and the mean time, sufficient information is given to plot the fix.

Fig. 4 illustrates a variation of this procedure which is very useful while flying a radio range beam. While it is necessary to take only one bearing with the direction finder, it will be seen that the known beam course effectually fulfills the function of a second bearing. In airline practice, this method of getting a fix with the direction finder is frequently used. Being very rapid and simple to perform, a fix obtained in this manner usually is accurate. It will be apparent that a pilot can use this system to check his position at any time while flying a beam. In fact, by precomputing what the side bearing should be at some selected point (or time) along the beam, it is easy to preset the loop to the correct azimuth reading. When the null is received, the airplane is over the selected point.

For example, in Fig. 4 assume the pilot wishes to ascertain the moment of

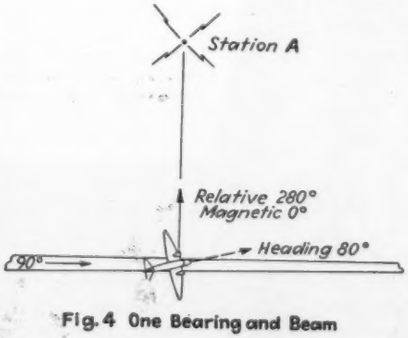


Fig. 4 One Bearing and Beam

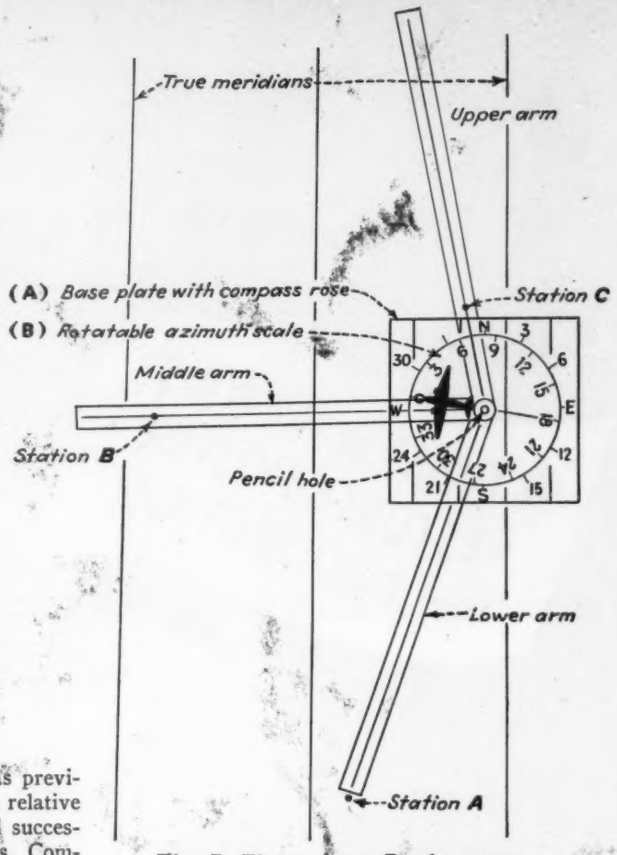


Fig. 3 Three Arm Protractor

passage over a point of station A due south. Having established a heading of 80 deg. magnetic is needed to hold the 90 deg. beam course, it is seen that the null pointer must be set to 280-100 deg. on the azimuth scale to obtain a magnetic bearing of zero deg. to the station. At the moment the null is received, the airplane must be due south of the station. Magnetic rather than true bearings are used for the sake of simplicity.

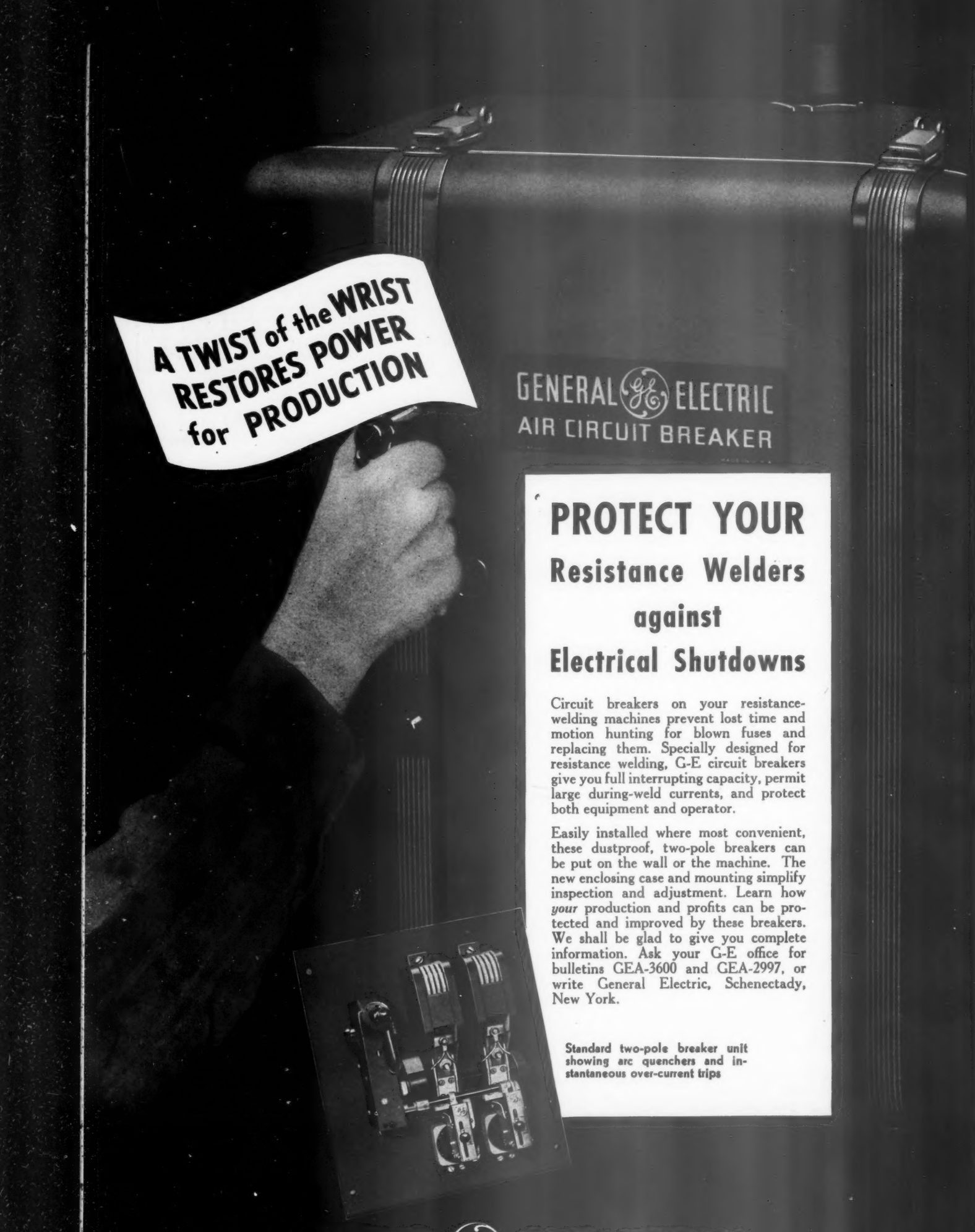
While two bearings and a heading represent the minimum requirements for a fix three bearings and a heading usually provide a more positive position. In this case the third bearing may be considered in the light of an added check. As will be shown when plotting is discussed, the third bearing often discloses inaccuracies in the shots and provides a means of evaluating the accuracy of the plotted position.

Taking three rather than only two bearings will often disclose possible errors introduced when converting the relative bearings to true or magnetic bearings. Often such errors are caused by a faulty compass rather than erroneous bearings. Having three relative bearings then, it is still possible to plot the position without using the heading.

Preparation Prior to Taking Bearings

Probably the most common mistake made when taking bearings for a fix in flight is starting to take the bearings without devoting sufficient advance

(Turn to page 162)



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Flying EQUIPMENT

Molding The Langley Airplane

By Randolph Hawthorne, *Aviation Magazine*

"LOOKIT the idjits, buildin' wood around an engine!"

Such was the scornful comment frequently met with by the builders of the new molded plastic plywood plane whose sleek, mirror-like mahogany beauty was recently revealed at Roosevelt Field, Long Island.

Despite the marked incredulity of certain aeronautical opinion, used to conventional aircraft materials, engineer Arthur F. Draper, former Navy pilot, and designer Martin Jensen, backed by Caleb S. Bragg, president, Langley Aviation Corp., Port Washington, L. I., remained unshaken in their confidence born of exhaustive testing and developing. Indeed, so great is their confidence that they would have installed plywood firewalls as well as plywood cowling, had CAA regulations permitted. The rules, however, specify metal, even though both stainless steel and aluminum alloy are demonstrably less resistant to fire than the Langley plastic bonded plywood.

The Langley plane, named for Samuel Pierpont Langley, pioneer American airman, is a low wing four-place cabin model powered with two 65 hp. Franklins which give it a top speed of 142 m.p.h., fully loaded with four passengers and 40 gallons of fuel. Only 200 ft. of runway is necessary for take-off, and with full load the plane climbs at the rate of 644 ft. per minute, cruises at 125 m.p.h., has a service ceiling of 15,000 ft., and lands at 46 m.p.h. Range is 600 miles.

With a wing span of 35 ft. and length of 20 ft. 6 in., gross weight is 2300 lb. and weight empty 1410 lb. The ship has been stressed for 90 hp. engines which will increase performance. The higher powered model, now building, will have a maximum speed of 165 m.p.h. and a cruising speed of 148 m.p.h., climbing at the rate of 1130 ft. per minute, and having a service ceiling of 18,500 ft. Weights will be 1560 lb. empty, and 2450 lb. loaded.

A versatile airplane, the Langley may be used for military training, or light bombing (the builders claim it could carry a bomb load of 1000 lb.), or for private flying. Because of the low cost of materials and a less expensive labor factor, the Langley airplane is expected to be very moderate in price.

It was largely with this object, that of producing a plane of good performance at low cost, and without running afoul of strategic materials placed on the priorities list, that the Langley builders set themselves to construct a plastic bonded plywood airplane.

After surveying all existing methods of plywood aircraft production, it was decided that the Vidal process offered the most possibilities—with modifications—and the rights to this method were therefore purchased.

The design for the twin-engined model was developed from a previous single-engined plane built by Martin Jensen in Charleston. This plane, however, employed nails to fasten the skin to the frame; a method not used on the Langley.

In choosing a plastic it was necessary to have one that could endure safely every conceivable temperature to which a plane might be subjected in

Martin Jensen, designer of the Langley airplane, about to take off in one of the first flights at Roosevelt Field, L. I. He won 2nd prize in the 1927 Dole trans-Pacific race.

2 photos by Aviation

It took the acetylene torch half a minute to burn through the asbestos-lined plastic bonded plywood used on the Langley engine cowls, but only two seconds to penetrate the stainless steel firewall required by CAA. Caleb S. Bragg, president of Langley, points to small hole made by the torch in the plywood.

Half the fuselage, complete with bulkheads, is bonded permanently into one unit. Here a fuselage shell is being lifted off its wooden mold. Doors and windows are later cut out with no consequent weakening of structural strength.

operation. It was found, after extensive tests, that the vinyl resins were the most suitable of known plastics for a temperature range of from —40 deg. F. to +160 deg., which is the range of endurance required by the Langley builders. The resin begins to flow at 200 deg., but it is unlikely such a temperature would be encountered in aircraft operations. The vinyls also will not support fungus or bacterial growth, are impervious to corrosion by acids, alkalis, gasoline and salt water, within the temperature range specified, and will resist fire. The vinyls, in fact, are among the most inert of substances, according to Mr. Draper.

In producing the Langley plane, the biggest problem faced by the builders was to overcome warping. Bent plywood will ultimately crack—first small cracks appear as if the paint alone was defective, but which, when removed, reveals the wood itself to be splitting from internal stresses. This problem was overcome by molding all parts used in the Langley airplane. Nothing was flat-pressed. And in molding the various structures, fluid pressure was applied which gave equal pressure in all directions.

After testing 50 or more resins, four were used in the present model. Although thermoplastic resins are preferred because of their greater tensile strength and greater reliability, some thermosetting phenols were used where necessary in final assembly.

Materials in Construction

The veneer material selected was "Honduras mahogany," which is the trade name for a certain type of mahogany found in Central America. This wood possessed the required strength to resist without crushing the molding pressures used in the Langley method. Most domestic woods currently used in plywood construction, such as spruce, will not stand up to these pressures, although the company believes it has found one domestic tree whose fibers will not break down.

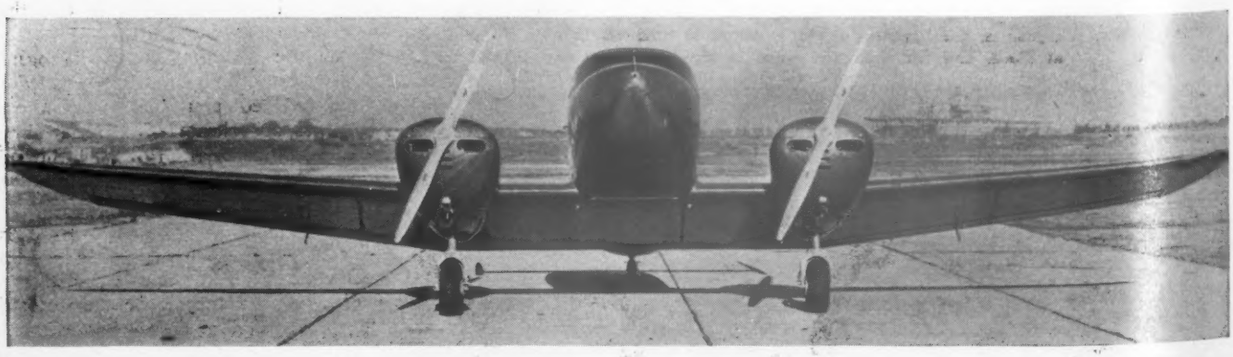
The veneer was all "flat-cut" mahogany; no "rotary-cut" wood being used. That is, the sheets were cut lengthwise along the timber, not around the circumference of the log. Thicknesses of the veneers range from 1/64 in. to 1/8 in.

In building the first Langley airplane, approximately 5000 sq. ft. of mahogany veneer and 60 gal. of plastic were used.

The resins employed were primarily the vinyls and phenols, which are received in solution—between 15 and 20 percent solids dissolved in alcohol. The vinyl resins, as mentioned previously, were chosen because they so far have been found best to endure the required temperature range of —40 deg. to +160 deg. F.

(*Turn to page* 154)

The sleek, mirror-like finish of the Langley airplane creates a minimum of drag. Landing gear is fixed in this plane, although later models will have their gear retract into the nacelles. Dark lines on the under surfaces are not cracks, but the reflection of the divisions in the concrete.



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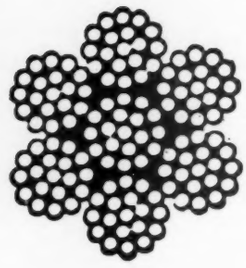

Fig. 1

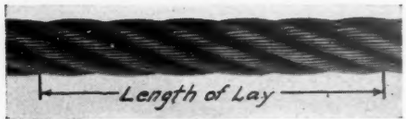

Fig. 2

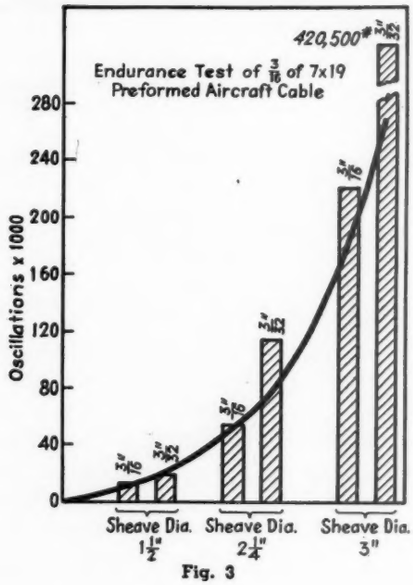

Fig. 3

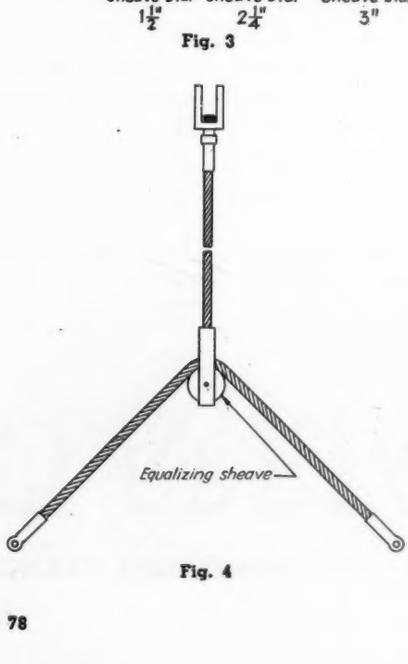

Fig. 4

Control cable problems which are presented most frequently by aircraft engineers are discussed in this article.

By R. F. Kolde *District Sales Engineer, Aircraft Department*
American Chain and Cable Co., Inc.

THE Ancient Romans—over 2,400 years ago—used cable and understood the elements of cable construction. That's how far back the basis for the design of modern aircraft cable extends. The earliest cables, as testified by a 15 ft. length of 1-in. diameter bronze rope now in the Musio Barbonico at Naples, consisted of hand beaten bronze wires twisted together by hand. Today aircraft cable wire is machine-drawn to a tolerance of .0005-in. and a tensile strength of approximately 320,000 lb. per square inch which is scientifically stranded and closed to a finished cable. But the basic idea of producing a flexible, yet strong, connector has not changed.

This conception seems so fundamental, so utterly simple, that many aircraft engineers give little or no thought to cable design and construction. Consequently, control cables comprising the important nerve system of a plane are not always given an opportunity to perform to their maximum capacity.

Often one or more special elements of a cable control system, usually because of cramped space, is designed with sheave pitch diameters much too small for optimum cable life. The result is invariably early fatigue failures necessitating frequent replacements with resultant insecurity. It cannot be overemphasized that excessively small sheaves materially shorten cable life. The reason for this is apparent. A control cable larger than 3/32-in. diameter is universally made in 7x19 construction consisting of 7 strands, each containing 19 individual wires, (See Fig. 1) while cables 3/32-in. in diameter and smaller are stranded in 7x7 construction.

The wires are laid into a strand in a symmetrical cross-sectional pattern with an accurately controlled length of lay. (See Fig. 2.) The strands are closed into the finished cable with a definite length of lay so that small spaces exist between adjacent strands.

When cable is moved over a sheave, or vibrated, each strand and each wire in each strand moves relative to its neighbor to adjust itself to its new position. Thus a cable may be regarded as a machine in itself with each component part—each wire—playing an important part in the resultant action of the cable as a unit. The relative motions of the individual wires, as a cable is moved over a sheave, as well as the various stresses in the wires and coefficients of friction between the wires, are so complicated as to defy accurate mathematical solution.

Observations, however, indicate that stresses set up in an operating cable increase tremendously as the diameter of the sheave over which it is operating decreases. When cable under tension is operated over excessively small sheaves, the strands and wires are forced into unsymmetrical positions and the severe localized stresses result in premature wire fatigue and "wire nicking". This leads to early cable failure. It is desirable that sheave diameters be maintained larger than an established minimum, known as the critical sheave diameter.

Critical sheave diameters vary slightly depending upon various manufacturing practices, cable loads, etc., but in general, the critical sheave diameter for any cable is that tread diameter smaller than which the cable strands cannot adjust their position to the bend. For 7x19 cable in sizes from 1/8-in. to 3/8-in. inclusive, the critical sheave diameter may be set roughly at 12 cable diameters.

Use of a sheave smaller in diameter than 12 cable diameters will result in marked decreased cable life. For instance, an AN-210-3A sheave, which has a tread diameter of 1.510-in., is

grooved to accommodate a 7/16-in. diameter cable. Although specifications do not recommend that this sheave be used with 7/8-in. diameter cable, it is, nevertheless, used at times in special installations. Since this sheave diameter is only approximately eight times the cable diameter, it is below the critical sheave diameter and, therefore, early fatigue failure of the cable invariably results. Accurately controlled laboratory tests indicate that, with this combination, cable failure as a result of wire bending fatigue actually occurs over 20 times faster than it would occur using a 3-in. diameter sheave under identical conditions.

Referring to the curve in Fig. 3, it can be seen that a 7/16-in. 7x19 cable used with a 1.5-in. diameter sheave ran approximately 20,000 reversals in a standard testing machine; whereas this cable used with a 3-in. diameter sheave such as an AN-210-4A ran approximately 420,500 reversals before failure occurred. A still larger sheave would result in a further increase of cable life.

Laboratory tests also prove conclusively that the relation of sheave groove radius to cable diameter is also of great importance in obtaining maximum cable life. A sheave groove radius equal to 1/2 of the actual cable diameter is ideal, as the cable is then afforded maximum support. A larger sheave groove radius allows the cable to flatten out on the sheave; while a smaller sheave groove radius pinches the cable. Both of these conditions lead to early cable failure as may be seen by referring to the bars in Fig. 3, although this illustrates only the former condition.

In considering sheave groove radii as well as sheave tread diameters, it should be recognized that maximum cable life is obtained when the cable is maintained as closely as possible to its original, symmetrical, circular cross-section.

It might be well to point out that critical sheave diameter applies to relatively non-operating as well as to operating cables. For instance, parking brake cable assemblies, which frequently consist of an inverted "Y" arrangement of cable (See Fig. 4) with an equalizing sheave or saddle at the crotch, should not embody a sheave or saddle with a diameter smaller than 12 rope diameters. Even though the cable moves very little over the equalizer, vibration may be sufficient to cause early cable failure at this point.

Cables operating over proper diameter sheaves, that is, sheaves larger than 12 times the rope diameter, are, of course, also subject to failure from wire bending fatigue. However, this type of failure has been minimized in recent years through the general use of Preformed cable. Preformed cable, originally developed by the American Chain & Cable Co., proved to be an important factor in eliminating internal cable stresses. In preforming, the cable wires and strands are formed into the exact shape which they assume in the cable before being closed into a finished cable. Thus, no pent-up stresses are present to enlarge the stresses encountered in service.

As a result, Preformed cable gives considerably longer operating service than does non-preformed cable. It facilitates faster production by virtue of its inert strands, which eliminates the necessity for seizing when the cable is cut to length. It also permits the use of swaged-end terminals—this will be discussed later—which also speeds production. For these reasons, Preformed cable is being used exclusively by manufacturers producing both Army and Navy planes.

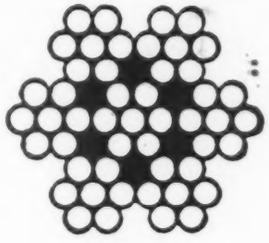

Fig. 5

Another fact overlooked at times by designers is that abrasion is second only to fatigue as a cause for early cable failure. It can readily be seen that the larger the diameter of the outer wires of a cable, the more resistant it will be to abrasion. It might seem that to combat abrasive wear a cable with large outer wires such as a 7x7 construction (See Fig. 5) would be desirable. However, as the diameter of the outer wires in a given diameter of cable is increased, the number of outer wires must be reduced, and therefore the cable flexibility is decreased and fatigue resistant properties are materially decreased.

Since practically all control cables are reeved through one or more pulleys, any increase in cable life which might be gained by increasing outer wire diameters and thereby increasing resistance to abrasion, would be lost through decreasing flexibility and thereby promoting early fatigue failures at the sheaves.

All of these points and more were taken into consideration before the 7x19 cable was adopted as standard. The 7x19 cable represents the best construction possible to resist the average abrasive and bending conditions found on a plane. This does not mean that under special operating conditions other cable constructions might not give longer service. Indeed, many isolated installations have been made using cable constructions either more or less flexible than the 7x19 construction as the case demanded, and greatly increased cable life has resulted. This is particularly exemplified in cable installations aside from airplane controls, such as for hoisting slings, mooring pendants, haulage ropes, etc. In installations such as these, 7x7, 6x37 and 6x37 Independent Wire Rope Center (See Fig. 6) are used very successfully to combat existing conditions. However, it is not considered practical by manufacturers to design each cable installation as a special case, and therefore the 7x19 construction in diameters from 1/8-in. to 7/8-in. inclusive is in general use for most all controls.

Control cables are frequently required to make bends of only a few degrees to clear some obstruction, and too often fairleads, rather than sheaves, are installed at these points. The result is relatively quick cable deterioration from abrasion of the cable outer wires.

In many cases, it may not be considered possible to install sheaves rather than fairleads when using 7x19 cable. In these cases, it should be borne in mind that, unless cable loads, cable movement, and angle of lead are exceptionally small, the cable is subjected to quick deterioration from abrasion. Likewise, unless the above conditions exist, the general run of fairlead materials now in use will quickly wear through and require frequent replacements.

(*Turn to page* 170)

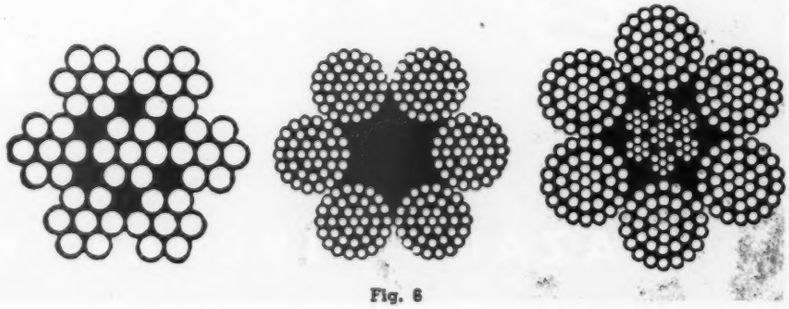

Fig. 6

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HAZARD AIRCRAFT CONTROLS

They Want To Help

Small business men and shop owners are emerging from obscurity to offer their skill and machines at the National Defense Clinics.

A WISPISH elderly gentleman wearing a frayed wing collar, black string tie and highly polished blue serge suit of antediluvian origin peered shyly over the half-moon lens of his battered spectacles as he approached the long exhibit table of a prime contractor at New York's recent defense clinic. In delicate, long-fingered hands he clutched a little package neatly done up with brown wrapping paper and old Christmas ribbon.

No one looked a second time at the professorial little man as he scanned the bewildering array of gears, shafts, rings and other objects comprising those parts the nation's largest manufacturer of precision instruments will gladly farm out to any subcontractors who can qualify. Unerringly, his glance carried down the long table until it reached a group of tiny shafts, plates and wheels of glistening steel. Carefully, he picked them up one by one, examining every detail. In diffident tones, he asked an attendant a few pertinent questions about the type of steel and functions of the parts. At this, the manufacturer's representative snapped alert and learned that the questioner owned a small machine shop in Jersey City.

Painfully shy, the genteel machinist hesitantly volunteered: "I want to help —there is plenty of demand for my work, but we can do more and I think we can turn out pieces like these to close tolerances."

A Subcontractor is Found

Asked about samples of his work, he nervously untied his package and from the folds of soft tissue in a holly-decked cardboard box withdrew several precision gages and small dies. They were of the hardest steel, machined and polished to mirror-smooth surfaces. The instrument man grew excited as he examined them. He ushered his "find" to a chair where a girl filled out forms concerning his equipment, floor space, personnel, etc., and made an appointment for a company engineer to visit the shop and pave the way for actual contract negotiations.

Next came a blithe-mannered individual who asked the instrument people if they had need of any jellies, creams or similar compounds made up in quantities to their specifications. After reflection, the answer was "No." It was explained that their lubricants were highly specialized oils and greases refined to highest specifications. The visitor wasn't interested in that but talked on and on about the wonderful compounds he could make.

It was all very pleasant, but nobody got any place. This gentleman obviously wasn't interested in adapting the skills and facilities of his establishment to urgent defense needs, but simply wanted someone to hand him more orders for something he'd been making happily for years.

This type of little businessman was the exception. Most of them indicated a ready willingness to learn new processes and make new products within the limitations of their present and potential resources. A great many had the initiative and foresight to turn up at the clinic with mimeographed copies of statements itemizing articles they currently produced or could make, along with complete descriptions of their machinery and other facilities. This procedure greatly simplifies the preliminary analyses of the prime contractor and saves considerable time for all concerned.

A pair of roughly-dressed workmen approached an exhibit table, looked over a few machined castings and held a whispered consultation. Then the older, acting as spokesman, forthrightly declared: "We can make this kind-a stuff. We gotta machine shop on Jones street." When the company man learned from them the type, variety and capacity of their machine tools, he agreed that they could probably do business together.

First National Clinic

More than half dozen state and region clinics had been held previously in industrial areas, but the New York clinic, held in conjunction with a National Defense Exposition for the public, was the first conducted on a national scale. Represented were 125 prime contractors from all parts of the country and 4,600 subcontractors from 26 states.

Army and Navy purchasing officials and OPM consultants also participated. It was estimated that more than 25,000 interviews took place between the participants during the three-day session September 22-24. A careful survey by OPM officials revealed these contacts were expected to develop into actual contracts for 2,661 smaller firms—makers of toys, musical instruments, dental supplies, fishhooks, silverware and so on.

At the end of the third day, a weary but generally happy crowd began packing up blueprints, specifications, exhibits and carefully tabulated records of promising potential subcontractors. Reactions were uniformly enthusiastic. An Army ordnance officer smilingly declared that his group had accomplished more in three days than normally would have been expected in six months.

Here again was eloquent tribute to the efficacy of those voluntary processes which are uniquely those of democracy; proof of the value of such governmental efforts to stimulate "farming out" of defense production.

Aviation Firms Successful

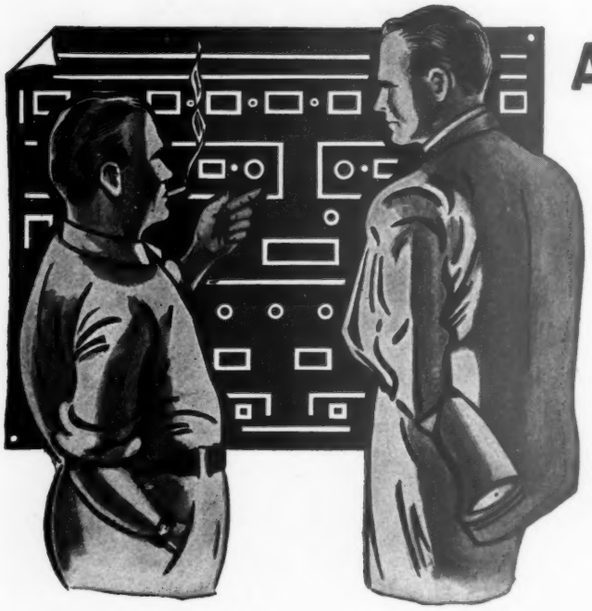
Aviation manufacturers and suppliers comprised the largest single category at the clinic. While their problems are more difficult than most, the aviation concerns, on the whole, met with considerable success. Wright Aeronautical officials felt the clinic was well worthwhile. The Glenn L. Martin Co. reported "pretty successful." Sperry Gyroscope Co. stole a march on most of the "primes" by showing up with seven men and a complete exhibit of parts it desired to subcontract. These men were pleasant talkers, well informed on their requirements, and a stenographic assistant took over the purely mechanical work of making out forms and records.

These latter points are extremely important, because the advantages of such clinics are likely to be nullified in large degree if things are not made as simple and easy as possible for the encouragement of little businessmen and small operators, many of whom are easily mystified and discouraged by elaborate specifications, complex blueprints and the endless "paper work" which is common to big business and the government.

As evidenced by actual incidents at the clinic, graphic representation of the

(*Turn to page 178*)

"SURE, WE CAN INCREASE PRODUCTION BY CHANGING OUR PLANT LAYOUT . . ."



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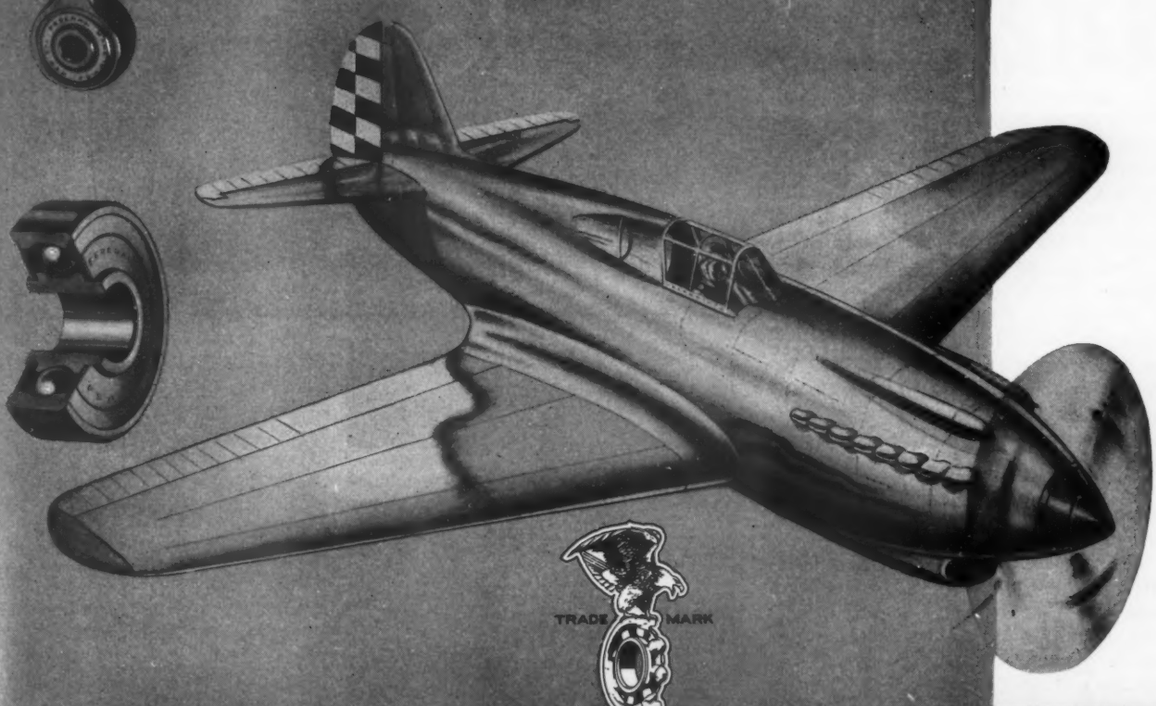

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Plated Aluminum In the Aircraft Industry

Covering of aluminum with nickel, chromium, cadmium, copper and brass offers new possibilities in aircraft work.

By Raymond F. Yates, *Vice President, Krome-Alume, Inc.*

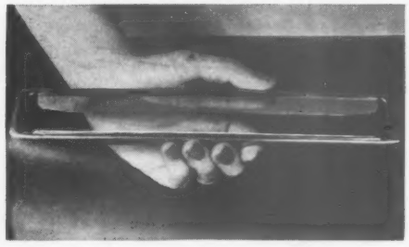
FOR many years aluminum and its alloys stood as the unplatable metals. They challenged the ingenuity of electrochemical engineers the world over and yet it was found practically impossible to plate any metal over aluminum except in a more or less precarious manner and with absolutely no assurances of continued adherence under conditions of stress, wear or ordinary atmospheric attack.

Aluminum was most difficult to plate for two reasons. First, it was what the electro-chemists call an electro-positive metal; that is, it is carried at a high positive charge. Secondly, like magnesium, it oxidized freely and quickly, even upon exposure to air at normal pressures and temperatures. What was more, this oxide film that was so rapidly formed was a non-conductor of electricity and a film even a few millionths of an inch in thickness would effectively prevent electro-deposition.

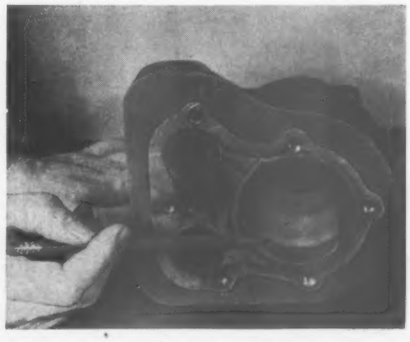
Thus the first efforts to plate aluminum were aimed at the elimination of this film. These efforts, however, were not successful and then an effort was made to etch the surface of the metal deeply, so that a form of mechanical adhesion could be established. Although some success was had with this method, it lent itself only to decorative purposes and did not make electro-plated aluminum available for other purposes.

The present process was developed early in the 1930s and it is predicated upon the establishment of an anodic film over the aluminum before it is plated. Normally this anodic film is not platable without further treatment. After the anodic film has been established, a quick modification of the film is made in either an alkaline or an acid solution, and this renders the surface available for plating in any one of the commonly used plating solutions. After this treatment, which requires about ten minutes, aluminum can be treated just like any other metal; it can be plated with nickel, chromium, brass, copper, cadmium, zinc, or even gold, silver and rhodium. Nor is there any limit to the thickness of the film that may be deposited.

Several patterns of pre-plated aluminum sheet material are offered commercially.



A sample of plated sheet aluminum stamped out after the sheet material had been plated.



A small aluminum piston plated inside with .0005 nickel and .001 chromium. After a long scuffing test the deposit was left untouched except for a high glare.

The equipment needed for this treatment of aluminum is simple and inexpensive and it is estimated that aluminum surfaces may be prepared for plating in any one of the common solutions at a cost of about a quarter of a cent per square foot. The electro-deposition of metals over these prepared surfaces proceeds normally and at the same rate of plating as on other metallic articles.

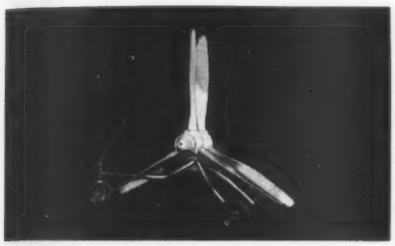
Several very important uses for this process have already been found in the aeronautical field. At the present time, both the Army and Navy are using aluminum variable air condensers that have been fabricated by soldering made possible by the deposition of nickel. So effective is this process for plating aluminum that soldering temperatures arrived at with ordinary equipment and ordinary 50/50 solder can be easily withstood and have absolutely no affect on the adherence of the plating.

As a matter of fact, the application of heat is believed to partially flux the aluminum and the nickel and to increase rather than decrease the adhesion of the metal. Several hundred thousand variable air condensers of this type are now being processed through the use of this method.

Through the deposition of brass over aluminum and aluminum alloy surfaces, rubber adherence may be brought to a point where it is limited only by the mechanical strength of the rubber itself. Prior to the appearance of this method of plating aluminum, special cements had to be used in cases where rubber was to be attached to aluminum. Even the best of these cements could not endure a strength test that exceeded 700 pounds to the square inch. In the case of brass-plated aluminum over which rubber has been molded and permitted to cure and age, tensile strength tests have come close to 4,000 p.s.i. at which point the rubber ruptured.

(*Turn to page* 146)

Engine Assembly Stand—Designed for maximum accessibility and adjustability.



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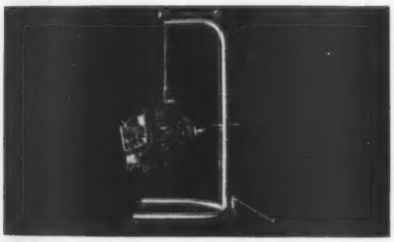
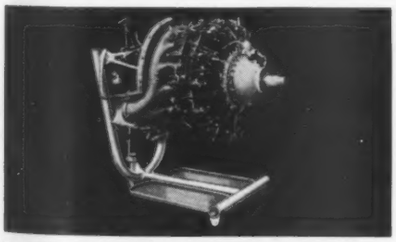


Engine Hoist of simplified design makes the engine easily accessible—from all sides.



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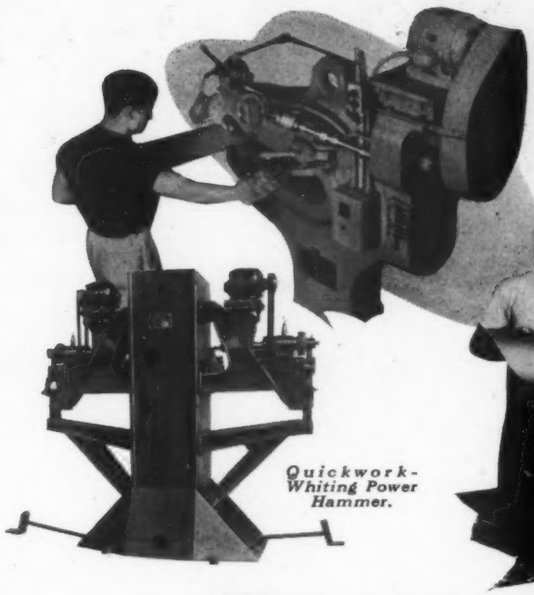

Quickwork-Whiting No. 20-A Rotary Shear in operation in the plant of Vultee Aircraft, Inc., Vultee Field, Calif.

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Non-Magnetic Instrument Plant

For eliminating outside magnetic fields to speed aircraft instrument production.

Adjusting the compensator on a new angle type Kollsman Direction Indicator. Accuracy to within one degree is required.

AN entirely non-magnetic building has been added recently to the Kollsman Aircraft Instrument Plant at Elmhurst, the purpose of which was to give greater speed and accuracy in the assembly and calibration of aviation compasses by eliminating any outside magnetic fields.

Obtaining these non-magnetic characteristics required the substitution of non-ferrous materials for the common materials usually employed. As the building was not too large, brick walls with huge cross beams were used. The first step, however, was to test the brick to make sure no ferrous materials went into their making.

The use of wooden beams solved the problem of a substitute for the usual steel girders, but in place of the steel base plates ordinarily used, special copper plates were employed.

All the pipes for the plumbing, heating and sprinkler systems, as well as the electrical conduits, are of copper. And in place of the usual cast iron drain pipe, there is a terra-cotta pipe which required special permission to use.

In order to eliminate the possibility of the metal delivery trays used in the remainder of the plant being pushed into the non-magnetic building, connection was purposely made to a separate level of the main building by means of a stair instead of the usual ramp. For moving material, a dumbwaiter, itself of non-magnetic materials, is used.

Maintaining the non-magnetic characteristics depended not only on the construction of the building but on its equipment also. Special benches, chairs, and other items of equipment had to be constructed of wood and composition board with copper screws and bolts in place of the metal chairs and benches used throughout the remainder of the plant.

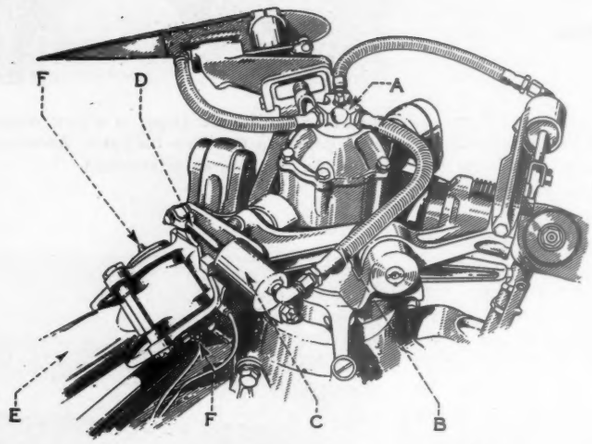
In this building not only the standard aviation compasses, but the new direction indicators, as well, are quickly assembled and calibrated. The elimination of the outside magnetic field with the consequent increased accuracy of callibration means more accurate compasses when they have been installed in the airplanes.

The new non-magnetic building of the Kollsman Elmhurst factory. Front portion is used as an employment office.

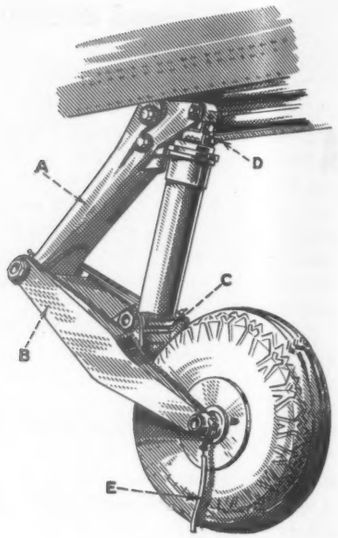
Checking the balance of the magnetic element of a Direction Indicator. To prevent disturbance by air currents, the element is enclosed in a glass ring.

A section of the non-magnetic plant. In the center of the picture the workers are adjusting compasses to close tolerances, work for which the non-magnetic feature is so important. Note wood ceiling and beams.

AVIATION SKETCH BOOK OF DESIGN DETAIL

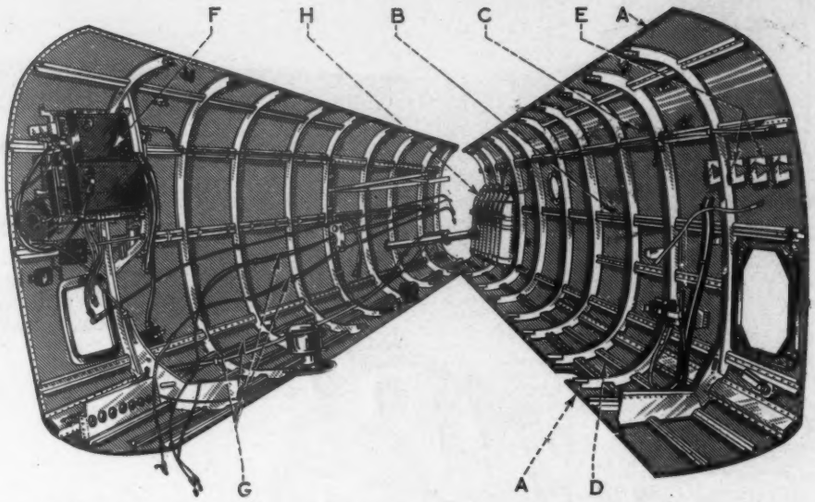


The rotor blade control mechanism on the Pitcairn autogiro PA-36, above, is operated hydraulically. The hydraulic fluid is forced up through the center hub mounting "A". From here it is transferred through tubes "B" to a cylinder "C" on the base of each blade. This operates a piston "D" which increases the pitch of the blades "E". The pitch is decreased, when the pressure is relieved, through the aerodynamic force on the blade. To allow for vertical blade movement, each blade is hinged along a line "FF".



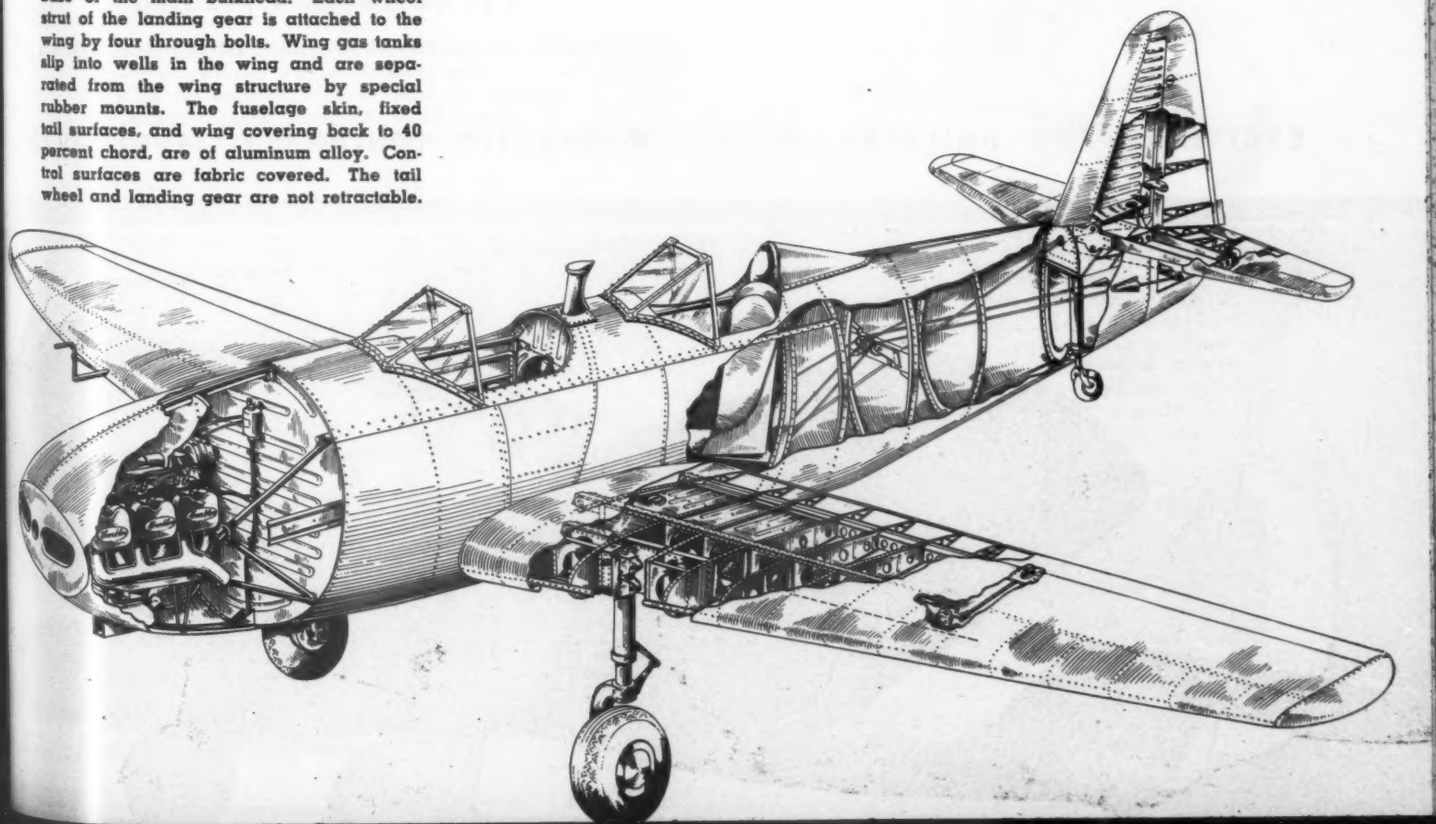
The retractable tailwheel of the Curtiss-Wright transport, above, uses a "knee-action" type structure made of built-up welded sections "A" and "B". The oleo shock absorber is attached at "C" with the air pressure valve at "D". "E" is a grounding cable for the ship.

The semi-monospar all metal two panel Messerschmitt wing construction, left, lends itself to quantity production. Outboard of the engine nacelles the wing is a true monospar type with accessibility provided through large removable panels. Basic wing construction consists of a nose section formed in a power brake operation; nose ribs formed with a punch press or drop hammer; hat section stringers formed from strip stock with power rolls; and main beam of extruded aluminum alloy angle cap-strips "E" riveted to an aluminum alloy plate shear web member "G" fitted with channel section stiffeners "F". Flat sheets of aluminum alloy are flush riveted into place to cover the wing aft of the nose section. The wing panels connect directly to the fuselage structure through a 4-point attachment between the shear webs and fuselage structure. Parts shown in the drawing are, "A" leading edge; "B" hat section truss members; "C" stamped Z-section rib formers; "D" channel section stamping; "E" angle section cap strip; "F" channel section stiffeners on the monospar shear web member "G", and aileron brackets "I" which are riveted directly to the ribs.



In the Messerschmitt 110, the fuselage, above, is a semi-monocoque type extending from nose to tailwheel bulkhead. The basic design is such that it is adapted to mass production, being divided into symmetrical halves, the skin sheets of which extend from the lower to upper center line "AA". In final assembly operation, the fuselage halves are joined by two rows of rivets passing through hat-section stringers, like "B", on upper and lower center line to form a complete structure. These halves could be assembled in simple vertical jigs arranged to give workmen free access to both interior and exterior surfaces, thus eliminating necessity for working in close, cramped fuselage interior. The structural design has bands of aluminum alloy sheet about 19 in. wide, with edges of each alternate band being rolled over into a Z-section "C" to form integral bulkhead rings. Bands adjacent to the formed sheets are flat sheets "D" sprung into place, with whole joined by flush riveting and joggled joints. Attachment brackets for electrical wiring are at "E", and the radio blind landing apparatus at "F". The almost complete absence of lateral bracing structure permits direct control system routing, with a minimum of fairleads and bellcranks for the empennage control system "G". Oxygen bottles "H" are filled through service connections.

The new Fleetwings advanced primary trainer, Model 33, is of spotwelded and riveted aluminum alloy construction. The fuselage is full monocoque with Z-section former rings aft of the rear cockpit. Engine is a six cylinder in-line Franklin behind which is a stainless steel firewall. The wing is of single spar construction, having two eye bolt attachment fittings for attachment to the fuselage. The main wing spar attaches just aft of the front cockpit at the base of the main bulkhead. Each wheel strut of the landing gear is attached to the wing by four through bolts. Wing gas tanks slip into wells in the wing and are separated from the wing structure by special rubber mounts. The fuselage skin, fixed tail surfaces, and wing covering back to 40 percent chord, are of aluminum alloy. Control surfaces are fabric covered. The tail wheel and landing gear are not retractable.



Curtiss

USES

VICKERS HYDROMOTIVE CONTROLS

Here is further evidence of the fact that Vickers Hydromotive Controls are used on many of the most modern airplanes. The Airplane Division of the Curtiss-Wright Corporation uses Vickers Hydromotive equipment on both the new giant 36-passenger Curtiss C-55 transport plane and the Curtiss SB2C-1 dive bomber for the U. S. Navy. Vickers Hydromotive Controls for aircraft do their job dependably, smoothly and accurately... no matter how severe the service.

VICKERS *Incorporated*

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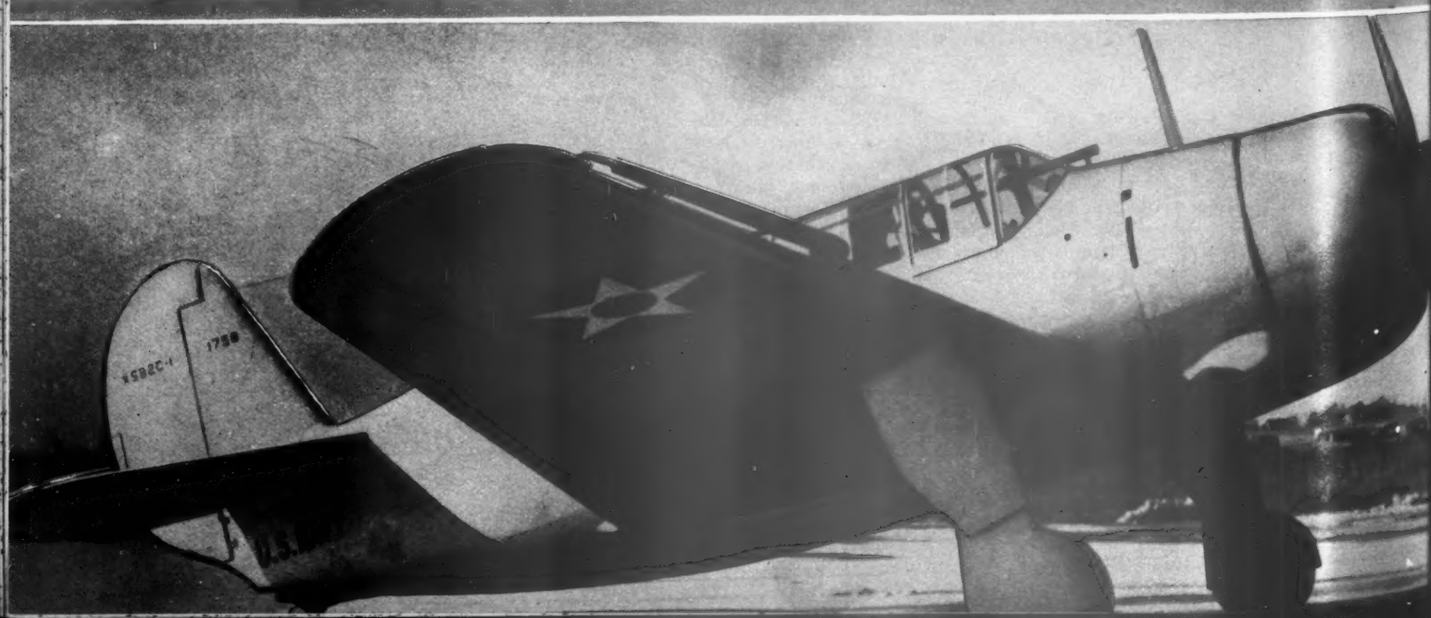
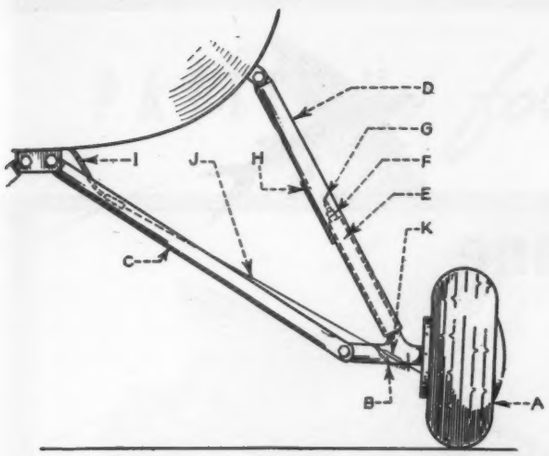
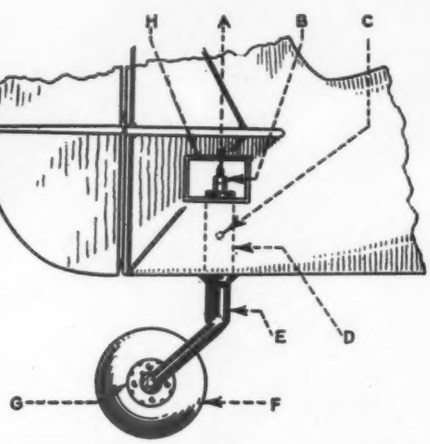
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

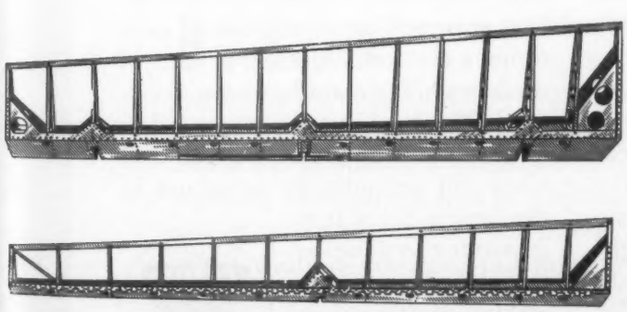




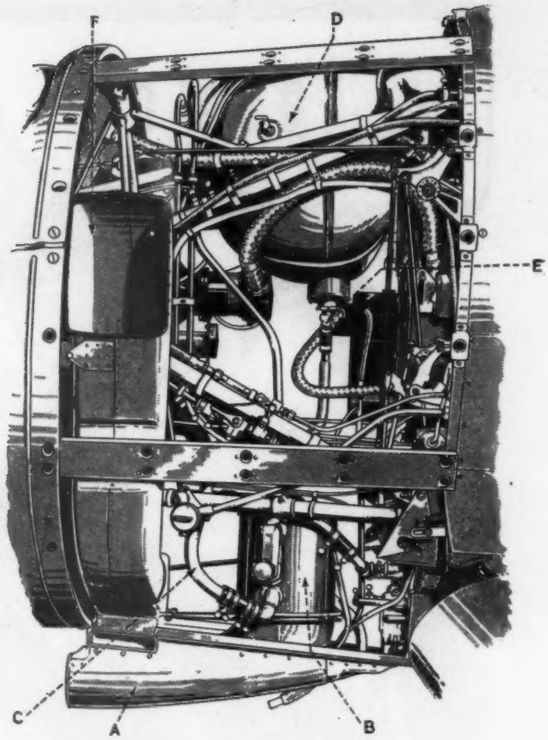
The landing gear of the Akron Funk Model B-75L, above, utilizes mechanical brakes, cable operated. In the accompanying sketch the parts referred to are as follows: "A" wheel assembly, "B" axle, "C" radius strut, "D" vee strut, "E" shock strut cylinder, "F" double nuts on piston, "G" filling plug—oil gage, "H" inspection plate, "I" brake cable conduit, "J" brake cable, and, "K" turnbuckle and spring.



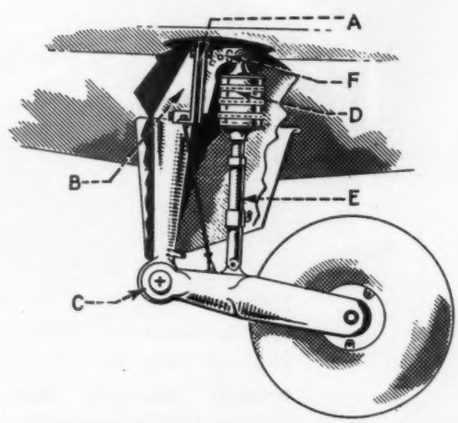
The tailwheel of the Akron Funk B-75L, above, is of the full swivel type with a hydraulic shock strut. The parts referred to in the drawing are: "A" plug and oil gage, "B"double nuts, "C" grease fitting, "D" shock housing, "E" shock tube and fork, "F" wheel, "G" grease fitting, "H" inspection plate.



The aileron of the Beech 18-S is of similar construction to the flap, utilizing a large triangular nose section of aluminum alloy. It is supported at three hinge points, however, and has formed ribs in the nose section. The wing flap of the Beech 18-S is of the hinge type with a large triangular nose section. To this are attached ribs formed of a single piece of aluminum alloy secured by a single rivet to the trailing edge.



The engine installation of the North American BC-1A is shown above. The intake for the oil cooler is at "A". The cooler "B" is located vertically with the oil entering from the engine at "C". The oil tank "D" has the connections to the engine at "E", and "F" is the carburetor air intake.



The landing gear on the Ercoupe makes use of knee-bend action to absorb the shock. The main landing gear strut is attached to the wing beam "A" by the fitting "B". This strut is hinged at "C" to allow for verticle movement of the wheel. The shock is taken up in the shock absorber "D" through the strut "E". This unit is mounted on the trailing edge of the wing beam at "F".

Seaplane

IT'S REALLY too bad nature didn't equip flying fish with propellers. For getting into the air is really no problem to them at all. They have the power to leap from the water at high speed, taxi along on their rapidly vibrating tails for several yards and readily "take off." But, lacking the means of aerial propulsion, their flights can last but a few seconds.

With man-made "flying fish," however, the situation is reversed. Once in the air, the seaplane leaves its most difficult problem behind. That's the matter of getting several tons of plane, gasoline, passengers, mail and freight "onto the step" and eventually into the air. And the bigger and heavier the ship, the more *power* the engines must have to break the tremendous drag of the water on the hull.

Thus much of the amazing development of the flying boat—as well as other aircraft—in recent years can be credited to improvements in engines and fuels. And it is to help in the continuation of this progress that Ethyl engineers cooperate with aviation engineers in a program of continuous research. Already a fund of useful technical data has been developed. Much of this information has already been applied. A great deal more will undoubtedly be of use in the future. All of it is important to aviation technologists who are seeking greater power for tomorrow's greater planes.

ETHYL

ETHYL GASOLINE CORPORATION

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

PATTERN *for* POWER

BEHIND the casting of a cylinder head for a Cyclone 9 lies a quarter of a century of painstaking foundry experience. Patient experiment with metals and sands has produced a technique for dissipating the roaring heat of explosions which create 1250 fifteen-ton power impulses a minute and make possible the 133 horsepower produced by each cylinder.

From the deft hands of master craftsmen have come moulding processes so expert that fins of metal as high as 2¼" and as thin as .064" can be formed by pouring molten aluminum into ordinary sand. These fins constitute the more than 15 square feet of surface that regulates the temperature of each cylinder when Cyclones power the ships of commerce and defense.

WRIGHT
Aircraft GINES

WRIGHT AERONAUTICAL CORPORATION • PATERSON, NEW JERSEY

Division of Curtiss-Wright Corporation

Aviation RADIO

Dialing the Air Waves with Craig Walsh

Cloud Heights Measured in Daylight by Photoelectric Method

The photoelectric method of measuring cloud heights at night has been in use for a number of years, but only recently has the method been adapted for use in daylight. Essentially, the daylight method is the same as the nighttime method, but instead of using a steady light beam for projection to the under side of the cloud, a pulsating beam is used. The calculation of the cloud height involves only the solution of a right triangle with one side and an acute angle known. The light beam is projected vertically into the air and at some known distance away a photoelectric detector is located. The elevation of the detector is varied until it points directly at a spot of light on the cloud and its angle of elevation noted. The cloud height is then the distance from the light projector to the detector multiplied by the tangent of the angle of elevation.

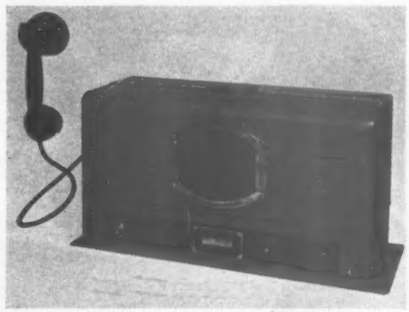
The constant intensity light beam cannot be used in daylight because it is impossible to locate the light spot on the cloud. If, however, a rapidly varying beam is used, a photoelectric detector can differentiate between the light spot on the cloud and the rest of the cloud surface. It should naturally contain in its amplifier circuit a filter tuned to the frequency of pulsation of the light beam. The operation of the daylight system is then as simple as the nighttime system.

The lamp used for this measurement is the tiny 1000-watt mercury vapor lamp developed by General Electric for searchlights and television studios. The projector consists of the lamp located at the focus of a 24-inch parabolic mirror having a 10-inch focal length. The photoelectric detector consists of a vacuum phototube placed immediately behind a diaphragm with a slit opening 3/25 by 11/16 inch located at the focus of an eight-inch plano-convex condensing lens.

The narrow beam from the 1000-watt lamp is projected into the sky at a frequency of 120 cycles per second and the rays scatter when they hit the cloud. This light scattering is detected by the photoelectric detector located at a known distance from the lamp.

Dark overcast clouds at an elevation of 9000 feet have been readily detected during daylight by this method. For cumulus clouds illuminated by direct sunlight and having elevations up to 4000 feet, the detection is positive.

This appears to be another forward step in the progress of aeronautical science to harness weather and increase the safety of flying.



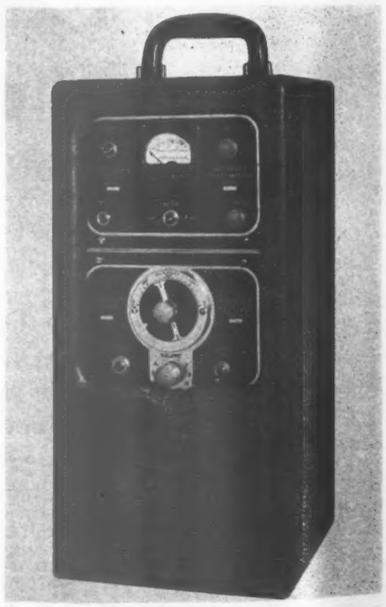
Portable transmitter and receiver unit made by Jefferson-Travis Radio Manufacturing Corp. for use in emergency vehicles.

Two-Way Radio for Airport Crash Trucks

A new two-way radio unit for use on airport crash trucks, ambulances, fire trucks is now ready for delivery by Jefferson-Travis Radio Manufacturing Corp., 374 Second Ave., New York. It has been designed to draw a small amount of power from the truck's battery because this type of truck seldom makes long enough runs to fully recharge the battery. This new unit, the model M-10, consists of a 10-watt crystal-controlled transmitter and a crystal-controlled receiver, both operating on one to four frequencies in the range between 2000 and 6000 kilocycles. Both loudspeaker and hand phone reception are provided. When the handset is used with an extension cord remote control is possible through the use of the push-to-talk button. The entire unit, including transmitter, receiver, and power supply, is enclosed in one cabinet measuring 19 inches long, 9 inches high, and 8 inches deep. The total weight is 28 pounds. The cabinet is designed so that it can be shock mounted in a number of different positions, thus making its installation a simple matter.

TWA Communication Range Doubled

The range of radio telephone communication on TWA planes was increased from about 500 miles to 1200 miles by the use of two newly assigned frequencies, i.e., 6510 and 10125 kilocycles. Previously, messages from planes more than 500 miles from the terminal ground station had to be relayed through one or more stations. The airline is completing the installation of new Bendix two-way radio communication equipment on its transports. These units will permit the use of the new frequencies merely by the addition of the proper crystals. The increased range of transmission is especially valuable when a plane is flying off the regular airlines.



Jefferson-Travis model PTR-5 transmitter receiver unit designed for temporary installation on airplanes for use during delivery of the plane or during training flights. It is contained in a single case and needs no installation work.

★ ★ ★

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Cabin Heating . . .

THE DELANEY GALLAY (SEALED SYSTEM) TYPE 40.P. is the latest and best method for supplying pure heated air to the interior of aircraft. Eliminates all Carbon Monoxide and foul air risks.

Steam generated by exhaust is used to heat the air. Special type of long-life boiler, simple, robust and safe.

CABIN DIMENSIONS	HEAT TO CABIN	AIR TEMPERATURE RISE
1,000 cub. ft.	150 h.p.	120° c.

Aerodynamic Radiators & Oil Coolers . . .

THE DELANEY GALLAY COOLING SYSTEM F. embodies improvements in construction which enable robust heat transfer elements in cupro-nickel, etc., to be employed instead of delicate tubes which present difficulties with regard to soldering and are liable to corrosion.

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We are desirous of marketing our products in U.S.A. and enquiries are invited from responsible organisations whose technical representatives are invited to make contact with our London Works.

Owing to war conditions bona fides of all enquiries must be verified. British and/or U.S.A. Government recommendations may be necessary.

THOUSANDS of our CABIN HEATERS, RADIATORS and OIL COOLERS are in use on BRITISH AIRCRAFT

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BALL BEARING DO'S AND DON'TS FOR MECHANICS

"If yer gonna turn th' steam on everything, turn some on yer mug," shouts Gus at Ab Plowhandle, our new mechanic from the sticks. Ab is washing down a ship's firewall, and steaming all the grease out of the control bearings. "That ain't no threshing machine you're workin' on," Gus reminds him . . .

GUS SAYS "DON'T!"

DON'T return new ball bearings to stock without putting them back in boxes or wrapping carefully . . .

DON'T do a welding job next to a grease-packed ball bearing; your grease won't last . . .

DON'T press a ball bearing into a housing by pressing or hammering on the inner ring.

Why Bearings Fail

Fourth of a series of instruction sheets published by The Fafnir Bearing Company, based on its experience with the leaders of U. S. aviation.

IF INSTALLED cleanly and properly, ball bearings will outwear most related parts. For example, ball bearings in control pulleys often outwear the pulley bodies.

STUDYING bearings that have failed, and finding out why, always brings us to one fact: Most bearing failures can be prevented by more care in bearing installations.

FIRST CAUSE of bearing failure is letting dirt get in, or damaging bearing while pressing or staking it.

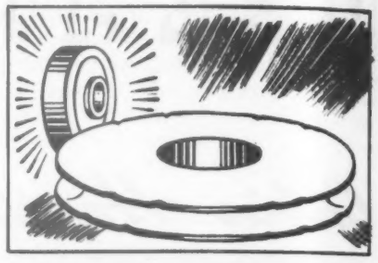
SECOND COMMON cause of bearing failure is careless wash-down of parts, permitting wash solvent or steam to "steal" lubricant from engine control bearings.

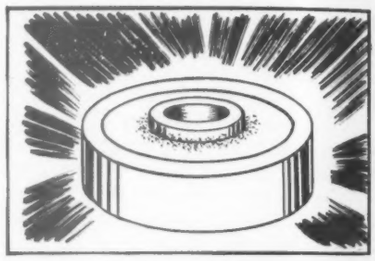
MIS-ALIGNMENT of rigid-type bearings at their installation kills many bearings young.

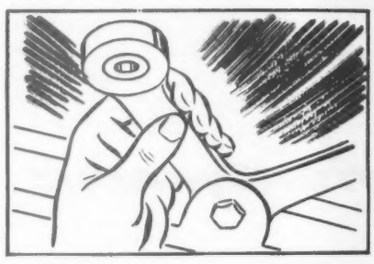
OTHERS FAIL because of entrance of moisture, or high temperatures.

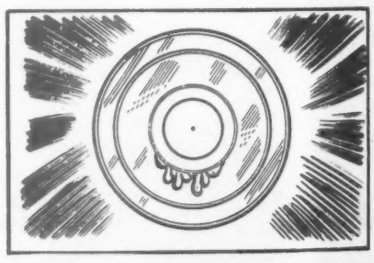
FRICTION OXIDATION or "false brinnelling", caused by undue vibration, can wear balls and races of a bearing that is clean and well lubricated.

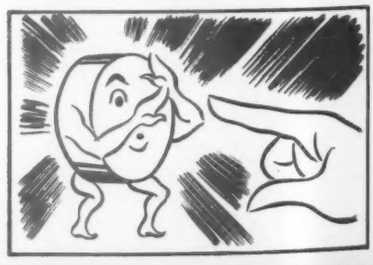
DON'T BLAME the bearing if you have an application that causes continual trouble. Let the Fafnir Aircraft Engineers check it and find the trouble. The Fafnir Bearing Co., Aircraft Div., New Britain, Conn.

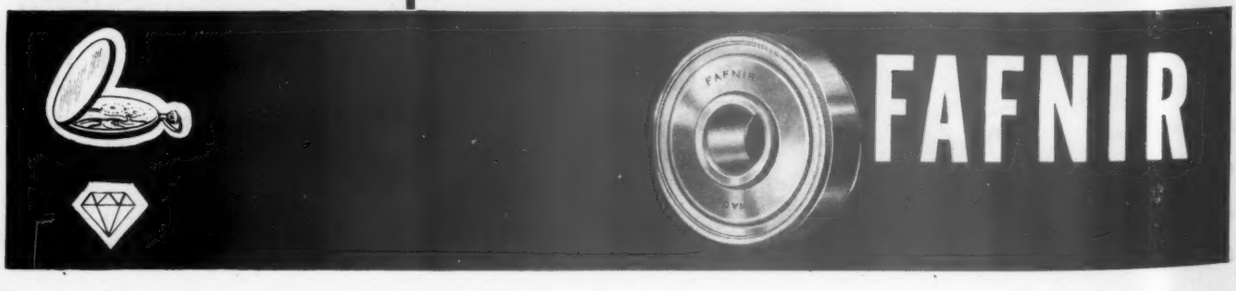












Aviation's Tax Hurdle

By Selig Altschul

THE key problem formerly confronting the aircraft industry was the attainment of smooth production in an accelerated program. Today, while that battle of production is constantly going on—and being licked, it is becoming increasingly evident that taxes are slated to become a far more important factor in the affairs of the aircraft group than previously imagined.

The full impact of the recently enacted 1941 tax law together with new taxes yet to come—foreshadowed and frequently cited in this magazine—has left its mark on the aviation industry. Severe as the Revenue Act of 1941 may be, it is at least digestible. It is the full implications of Secretary Morgenthau's proposal for next year to limit profits to 6 percent on invested capital, however, that served as an unsettling influence and proved very disturbing to the future of corporate enterprise.

A brief review of the 1941 tax law and its effect on representative aircraft builders illustrates the significance of any further and more drastic imposts. The current act raises the effective top bracket rate on corporate incomes to 72.4 percent from 62 percent. The top rate will also be applicable to a larger proportion of earnings, particularly in the aircraft group.

The provisions dealing with excess profits taxes are the most important and it is in this department that the bulk of corporate profits will be sloughed off. Stated simply, this is a graduated scale of taxation on all earnings in excess of either 95 percent of average net income in the base period or, alternatively, using invested capital, in excess of 8 percent on the first $5,000,000 plus 7 percent on the remainder.

It is important to note that the taxpayer has the option to choose one of two bases in determining the amount of excess profits taxes to be paid. Under the average earnings option, the base period represents the average annual earnings for four fiscal years beginning after December 31, 1935 and before January 1, 1940. Further, as growth companies, aircraft builders are entitled to greater exemptions in computing their taxes under the average earnings option. (This formula for "growth" companies is explained in detail in AVIATION for April, 1941).

While aircraft earnings did not reach important proportions until recently, the exemptions allowed under this "growth" provision exert a significant ameliorating influence on the taxable net income.

The invested capital option, being rather onerous in its application to the aircraft builders, is studiously avoided as a base. In relation to its total gross sales and net income, the aircraft industry has a relatively small capital investment and would be severely taxed on this basis.

As an illustration of the decided contrast in excess profits tax credits under the two optional methods, Table I presents estimates, as prepared by a leading statistical organization, of earnings and excess profits tax exemptions for representative aircraft companies. This table further presents estimated earnings for these companies for the year 1941.

TABLE I

Excess Profits Tax Credits And Earnings Estimated For Leading Aircraft Companies

	Est. Excess Profits Tax Credit Based on: 1936–39 Ave. Earn. (000 omitted)	Invest. Cap. (000 omitted)	Per Common Share Actual Net After Taxes 1940	Est. 1941 Max. Exempt. From E.P.T.	Est. 1941 After All Taxes
Boeing (A)	$3,000	$900	$0.35	$0.57	$4.50–$5.00
Consolidated (B)	1,670	690	1.15	0.83	4.50– 5.00
Curtiss-Wright	6,000	3,160	1.81	0.25	2.30
Douglas (C)	8,460	1,161	18.05	9.73	15.00
Grumman	1,020	240	2.79	1.39	3.00
Lockheed	3,010	2,020	3.17	2.07	6.60
Martin	5,380	1,540	4.94	3.38	6.00
North American	7,850	890	2.06	1.58	2.15
Sperry (A)	7,270	1,280	3.90	2.49	4.50
United Aircraft	11,500	2,530	4.95	2.99	4.50– 5.00

NOTES:
(A) Includes domestic companies only.
(B) Adjusted for 100% stock dividend.
(C) Company's fiscal year ends Nov. 30. Exemptions based on 1940 Act.

A glance at the respective estimated excess profits tax credits clearly shows the importance to the aircraft industry of retaining the option to use the average earnings base in computing its excess profits taxes.

While the calculation of what represents invested capital is a complicated ritual, there is little doubt that were an excess profits tax based on 6 percent of invested capital in effect, earnings available for stockholders would be reduced to minuscule proportions.

The consequences of such a policy would be immense. Gone would be any incentive to achieve greater efficiency in operations and all of the attendant benefits that flow from such a policy.

While best informed sources believe that the Treasury Department's proposal has little likelihood of being adopted, it nevertheless deserves careful attention. Twice before the Treasury attempted to confine excess profits taxation to the invested capital base, but was defeated on both occasions. Some observers believe that the intention of this latest proposal was to introduce the most drastic tax bill possible so that a good trading position may be established to enact a 1942 tax bill which while not so confiscatory, would nevertheless be far more severe than the existing law.

It is this wider realization that come what may, ever-increasing taxation is assured, that is responsible for aircraft and other equities being in strange disrepute among investors.

This anxiety of the moment, which is nothing but fear of state socialism, is undoubtedly the cause of stagnant and lower markets for aircraft and other vulnerable securities. This apprehension, however, is without validity, when we examine the English scene as a clue to the future. In many respects, the British are much further advanced in gearing their economy not only to war conditions but for a post-war period as well. It is accordingly very significant that in England, faced by an after-the-war Labor Party program for nationalization of transport by land, sea and air, along with nationalization of land and banks, the stock market is still advancing. The London Financial Times industrial-share average recently reached a new high for the year and attained the highest level since March, 1940. As a barometer of coming events, the London market, despite existing profit curbs on business and the unknowns beyond, takes a rather optimistic view of the future. If we are willing to apply the London action as a guide, the threat of Socialism as a long-term factor to American enterprise may prove grossly exaggerated.

In any event, our own aircraft equities have floundered market-wise on the least bit of disturbing news. Possibly, it is the combination of many factors that has led to this noticeable weakness in the aircraft group. The ever-present

(*Turn to page* 158)

BUYER'S LOG BOOK

What's New in Accessories, Materials, Supplies, and Equipment

For tool and light snagging grinding, *Hammond Machinery Builders, Inc.,* 1638 Douglas Ave., Kalamazoo, Mich., have three new functionally streamlined grinders, the "OK" models 10, 12, and 14. Design of machines stresses oversize construction for all moving parts such as spindles and bearings. Streamlined into base at top is a heavy duty motor-on-spindle for 10, 12 or 14 in. wheels, 1, 2 or 3 hp., having spindle speed of 1750 r.p.m., operating on 220 or 440 v., 3 phase, 60 cycle a.c. Standard equipment includes motor with oversize ball bearings sealed against dust; push-button starter; heavy exhaust-type, semi-steel guards; adjustable spark deflectors and tool rests; tool tray and removable water pot.—AVIATION, *November, 1941.*

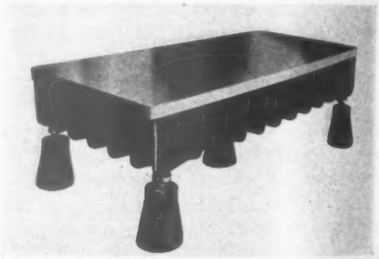
Hammond Mach. "OK" grinders

A new hydraulic vise, capable of developing pressures up to 5 tons between the jaws, has been introduced by *Studebaker Machine Co.,* 9 South Clinton St., Chicago, Ill. Designed to speed up small press and cutting operations, as well as ordinary vise work, the vise is operated entirely by foot control, thus freeing both hands for setting up and removing work. Unit needs no outside power, and is understood to have wide application on production lines, in tool rooms and for maintenance. The hydraulic fluid is carried by a steel tube from a pedal pump arrangement to a ram behind the back jaw. Stepping on one pedal moves the vise jaw to contact against work; second pedal applies pressure up to 5 tons, and a third releases jaw. Mounting horizontally on any type bench, as well as vertically on wall or post, vise may, in addition, be mounted on a portable stand as a movable, self-contained unit. Two sizes are available—5 in. width between jaws and 7½ in. width.—AVIATION, *November, 1941.*

Studebaker Machine vise

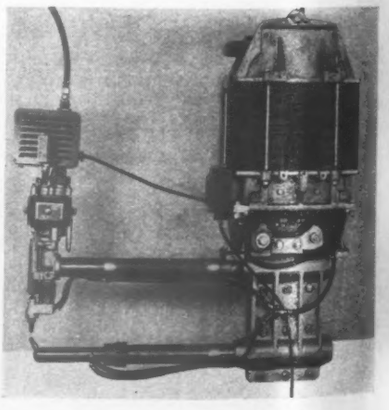
Complete protection for threaded aircraft tubing while in storage or transit is provided by the new Seal Plugs manufactured by *Tubing Seal-Cap, Inc.,* Los Angeles, Calif. In addition to protecting threads these caps prevent dirt or moisture from entering the aircraft tubing and may be re-used repeatedly. Manufactured from light metal, provision is made for sealing after preliminary inspection, greatly reducing possibility of sabotage. Stocks are now available in a range of nine sizes to fit tubing of ¼ in. to 1 in. size.—AVIATION, *November, 1941.*

Surface Plate, cast in semi-steel and finished plane within .005 in., made by *South Bend Tool & Die Co.,* 1900 S. Main St., South Bend, Ind., offers seven specific support points for utmost flexibility in usefulness. Two sizes of adjustable blocks or legs (10 in. and 12 in.) provide possible working surface heights between 29 and 33 in. The blocks support threaded 1½ in. screws, each topped with circular cap recessed to contain any of the projecting support points on bottom of plate. A 12-pitch thread provides fine adjustment for floor irregularities. The ribbed under side of the plate is designed to provide maximum strength without excessive weight. Weight of plate is 3 tons. —AVIATION, *November, 1941.*



South Bend Tool surface plate

A line of portable welding machines, with built-in transformers designed for suspension from monorails, has been announced by *Progressive Welder Co.,* 3050 E. Outer Dr., Detroit, Mich., which are obtainable in a complete range of sizes from 35 to 400 kva. Possessing particular advantages in such applications as spot welding of large or heavy units requiring clearance from ground under welding arms; spot welding of parts on a conveyor; spot welding assemblies in several jigs in one department, requiring movement of welding equipment; pinch welding of spots not easily accessible with gun type welders because of throat limitations, and jobs which can be handled most effectively by unit suspended from swinging or traveling crane, the new welders are a cross between pedestal and gun welders. Arms are adjustable as to length and are rigidly supported in the housing. Gun is direct air operated with pressure cylinder, solenoid operating valve, and control circuit pressure switch. Electrode tips are water-cooled, and foot controls connect to circuit junction box on transformer by flexible cable.—AVIATION, *November, 1941.*



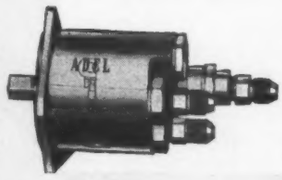
Progressive portable welder

Design Simplicity Reflected in Production

ADEL Series "J" standardized multi-purpose, direct drive, vane type fluid metering pump—for carburetor, propellor and windshield anti-icing protective functions.

ADEL Line Support clips—PROVEN—43,000,000 in use on U. S. Army Air Corps, U. S. Navy, British Air Ministry and Commercial Aircraft—under every conceivable condition in all parts of the globe.

ADEL Hydraulic Control Valve—one of four basic assemblies upon which are predicated over fifty single, dual, triple, quadruple and quintuple standardized selector valve units.



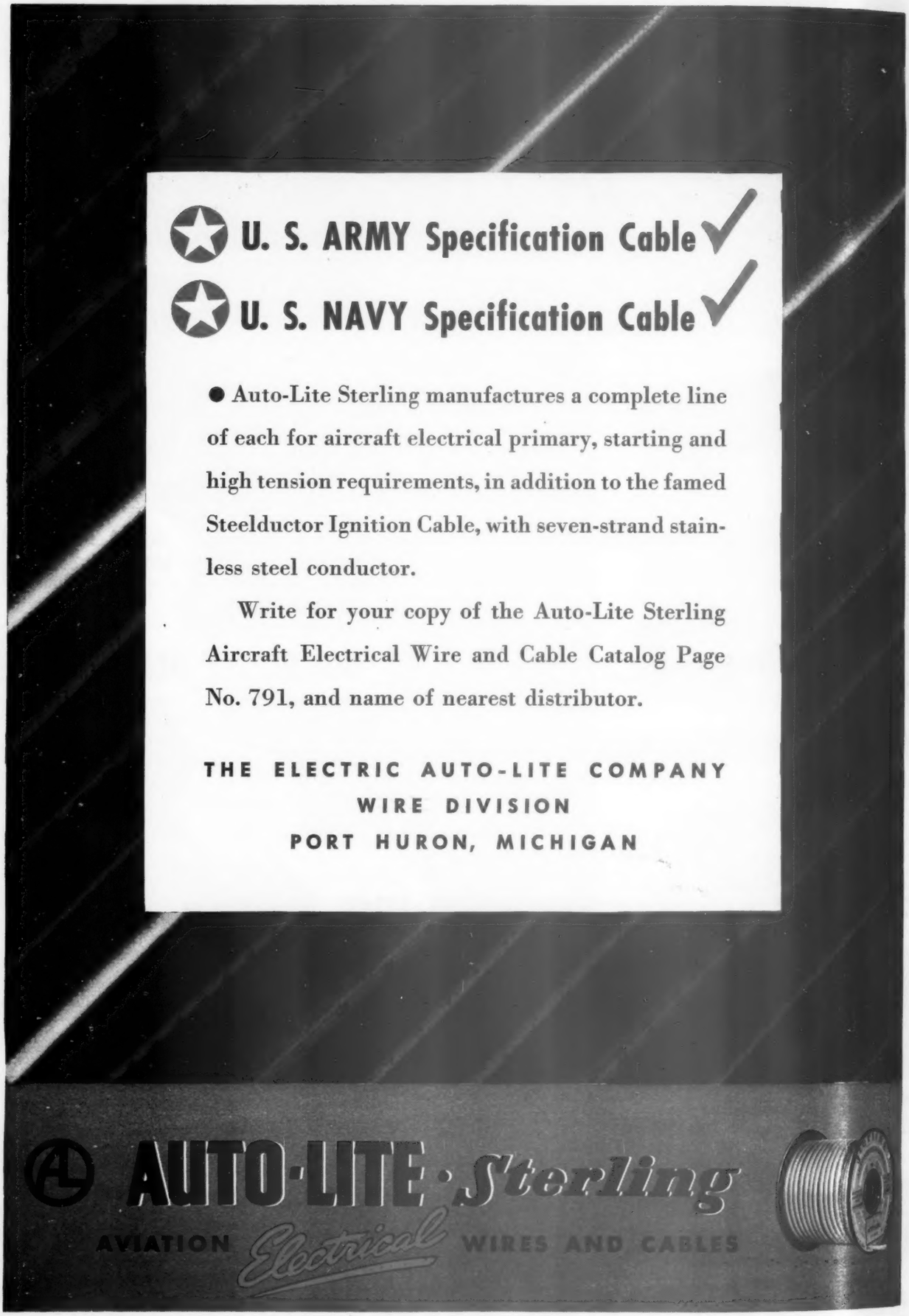
QUARTERLY DELIVERIES

- OCT. 31 $25,455 1939
- JAN. 31 $66,839 1940
- APR. 30 $89,434 1940
- JULY 31 $125,771 1940
- OCT. 31 $201,643 1940
- JAN. 31 $304,269 1941
- APR. 30 $594,996 1941
- JULY 31 $919,344 1941
- OCT. 31 $1,325,456 (estimated) 1941

Eastern Sales Engineer
J. HENRY REISNER
Hagerstown, Maryland

ADEL PRECISION PRODUCTS CORP.

10777 VAN OWEN BURBANK, CALIFORNIA

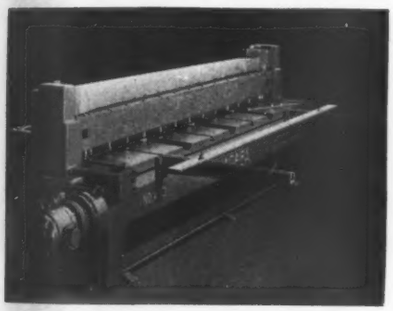

U. S. ARMY Specification Cable
U. S. NAVY Specification Cable
● Auto-Lite Sterling manufactures a complete line of each for aircraft electrical primary, starting and high tension requirements, in addition to the famed Steelductor Ignition Cable, with seven-strand stainless steel conductor.
Write for your copy of the Auto-Lite Sterling Aircraft Electrical Wire and Cable Catalog Page No. 791, and name of nearest distributor.
THE ELECTRIC AUTO-LITE COMPANY
WIRE DIVISION
PORT HURON, MICHIGAN
AUTO-LITE · Sterling
AVIATION Electrical WIRES AND CABLES

Udylite automatic polishing machine

An automatic polishing machine for buffing aluminum aircraft engine pistons is a new development by *Udylite Corp.*, Detroit, Mich., which is said to have reduced production time by 97½ percent in comparison with hand-buffing method on manually operated buffing lathe. Machine is said to buff sides and top of piston in 15 seconds, with only one operator to load and unload. Machine consists of an index table which indexes automatically. Twelve chucks hold pistons which rotate during buffing. The chucks are stationary during indexing period and during loading and unloading. Six buffing pedestals arranged around machine accommodate buffing wheels which are driven through "V" belt drive. Buffing pressure is adjustable by means of tension spring so that buff rides over work to provide uniform buffing pressure at all points. Wheels may be adjusted at any angle. Machine may be adapted to variety of circular parts merely by changing work holding chucks or fixtures.—AVIATION, *November, 1941.*

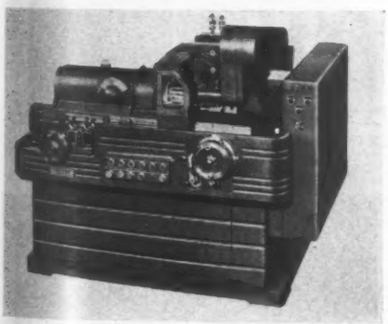
Dobeckmun Cellophane bags

"Cellophane" bags to contain aircraft parts should have wide application in the industry, especially in sub-contract parts. *The Dobeckmun Co.*, Cleveland, Ohio, have recently completed a printed "Cellophane" bag for parts which permits easy writing with pencil or hand stamping. With these bags, quick identification is afforded both by writing on the face and fact that part can be seen, and since bag is moisture-proof, protection from rust is assured. The compactness of the package, and because it accommodates itself to product in size, greatly reduces storage space required both for empty containers and for the finished product. This reduces size and weight of shipping containers. Also, by crimping top of bag with a set of heated jaws, bag becomes tamper-proof and cannot be opened without detection.—AVIATION, *November, 1941.*



Niagara Mach. power squaring shear

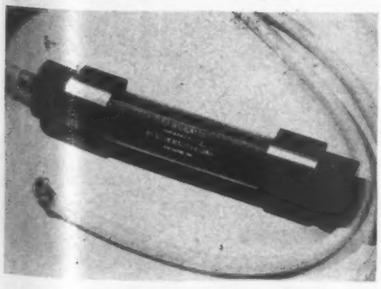
A new line of power squaring shears having higher operating speed was recently announced by *Niagara Machine & Tool Works,* Northland Ave., Buffalo, N. Y. Sheared edges can reliably be cut that are straight to within a very few thousandths of an inch of a straight line, it is said, without any special skill of the operator. Narrow strips, accurate to gage setting and parallel within close limits, are easily produced without camber or curl. Strips may be cut at rate of 75 per minute on 60 cycle current. Drive, including flywheel, gearing, clutch, eccentrics and connections, are wholly enclosed within machine and operate in bath of oil. A new detent device completely replaces customary friction brake and requires no adjustment or attention. Standard equipment includes a direct connected 3 phase, 60 cycle, 110 or 220–440 volt a.c., ball bearing, splash proof motor with magnetic starter, push-button control; pair of 4 cutting edge tool steel knives; adjustable scale inlaid at each end of bed; side and bevel gages, etc.—AVIATION, *November, 1941.*



Ex-Cell-O thread grinder

Automatic in operation, a new thread grinder for internally threaded work, known as Style 39A, has been brought out by *Ex-Cell-O Corp.*, 1200 Oakman Blvd., Detroit, Mich. It grinds threads up to 5 in. in length within a distance of 15½ in. from work spindle nose. Maximum hole ground is 9½ in. with a minimum of 1 in. Maximum swing is 10 in. Taper attachment is available that allows grinding up to a maximum of 4 in. in diameter per foot on the effective thread length.—AVIATION, *November, 1941.*

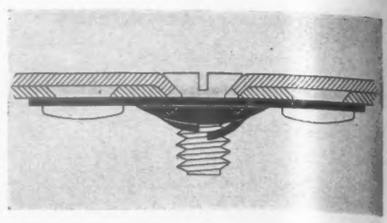
Synchronized to print and develop Ozalid sensitized materials in one continuous operation, the new Model C Whiteprint machine, recently placed on the market by *Ozalid Products Div.*, General Aniline & Film Corp., Johnson City, N. Y., brings into the print making picture a medium priced, easy to operate machine that will produce prints at speeds up to 12½ ft. per min. By its ability to use cut sheets as well as continuous yardage, the Model C will meet peak production demands. It accommodates materials up to 42 in. wide. An automatic device separates the sensitized material from the original which, after printing, is delivered to operator in a receiving tray.—AVIATION, *November, 1941.*



Multiproducts Bendix Dehydrator

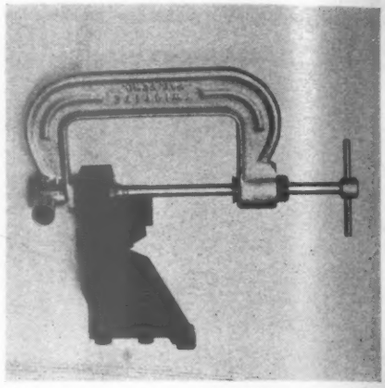
The Bendix Dehydrator, for use in aircraft to prevent the entrance of moisture into the streamlined housing of loop antenna used with Bendix Automatic Radio Direction Finding Equipment, is made by *Multiproducts Tool Co.*, Newark, N. J., for Bendix Radio Corp., Baltimore, Md. Housing is treated and sealed so as to be nearly airtight. Hose connection between housing and Dehydrator Unit permits air to breathe freely in and out of housing as plane flies at different altitudes. The Dehydrator excludes moisture from this air. Without the Unit, moisture enters housing during breathing process and condenses because of temperature change with result that the housing actually collects water, damaging to delicate apparatus within. Cylinder is molded of transparent Lumarith with ends of black Lumarith.—AVIATION, *November, 1941.*

New flat-anchor type Speed Nuts have recently been made for blind mounting and flush-blind mounting assemblies by *Tinnerman Products,* Inc., 2070 Fulton Rd., Cleveland, Ohio. Said to weigh only 20 percent as much as conventional fastenings of similar fittings, these Speed Nuts are designed with a ball formation surrounding the prongs of the nut sufficient to span the standard dimpling for counter-sunk flat head screws or bolts. Made of special molybdenum aircraft spring steel, they are said to have remained tight under the severest vibration tests, have speedier application and result in drastic cost reduction.—AVIATION, *November, 1941.*



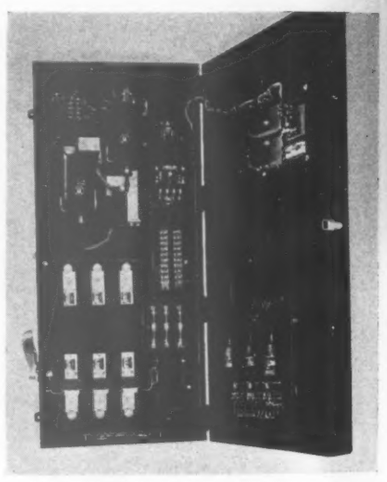
Tinnerman flat-anchor type Speed Nuts

New welders' ground clamp, which eliminates ground clamp failure, said to be a feature of the adjustable Twistite C Clamps, is now being offered by *Michigan Clamp Co.,* Box 243, Jackson, Mich. This clamp combines instant adjustment feature with spatter-proof treatment on the frame, pressure rod and swivel foot. The swivel foot turns on a ball bearing which assures a positive ground. The stationary foot, to which the ground cable is attached, is insulated from the frame, thus preventing the weakening of the frame by the heat of the heavy ampere welding current. A solder lug is provided to hold the welding cable.—AVIATION, *November, 1941.*



Michigan Clamp Twistite "C" Clamp

A flexible coupling which can serve as a connecting medium for oil lubricating lines, as well as being capable of transmitting torque, is added to the "Torflex" line by *Harris Products Co.,* 5407 Commonwealth Ave., Detroit, Mich. The new type "D" coupling can be "run-up" without special tools and special shaft preparation is not needed. Couplings can be used as replacements irrespective of the type of preparation used on shafting for old coupling. It is also said any shafting between ¼ in. and 5/16 in. inclusive can be handled by the new style, non-reversible type. Two metal caps and two rubber bushings are used in the coupling, but the spacer, which is required to keep the rubber bushings separated so that they will tighten onto shafting when caps are screwed together, consists of a nipple and two fiber washers instead of the double end all metal type. Torque capacities range up to 45 lb./in. at recommended usages and will compensate for high parallel and angular misalignment depending on size of shafting.—AVIATION, *November, 1941.*



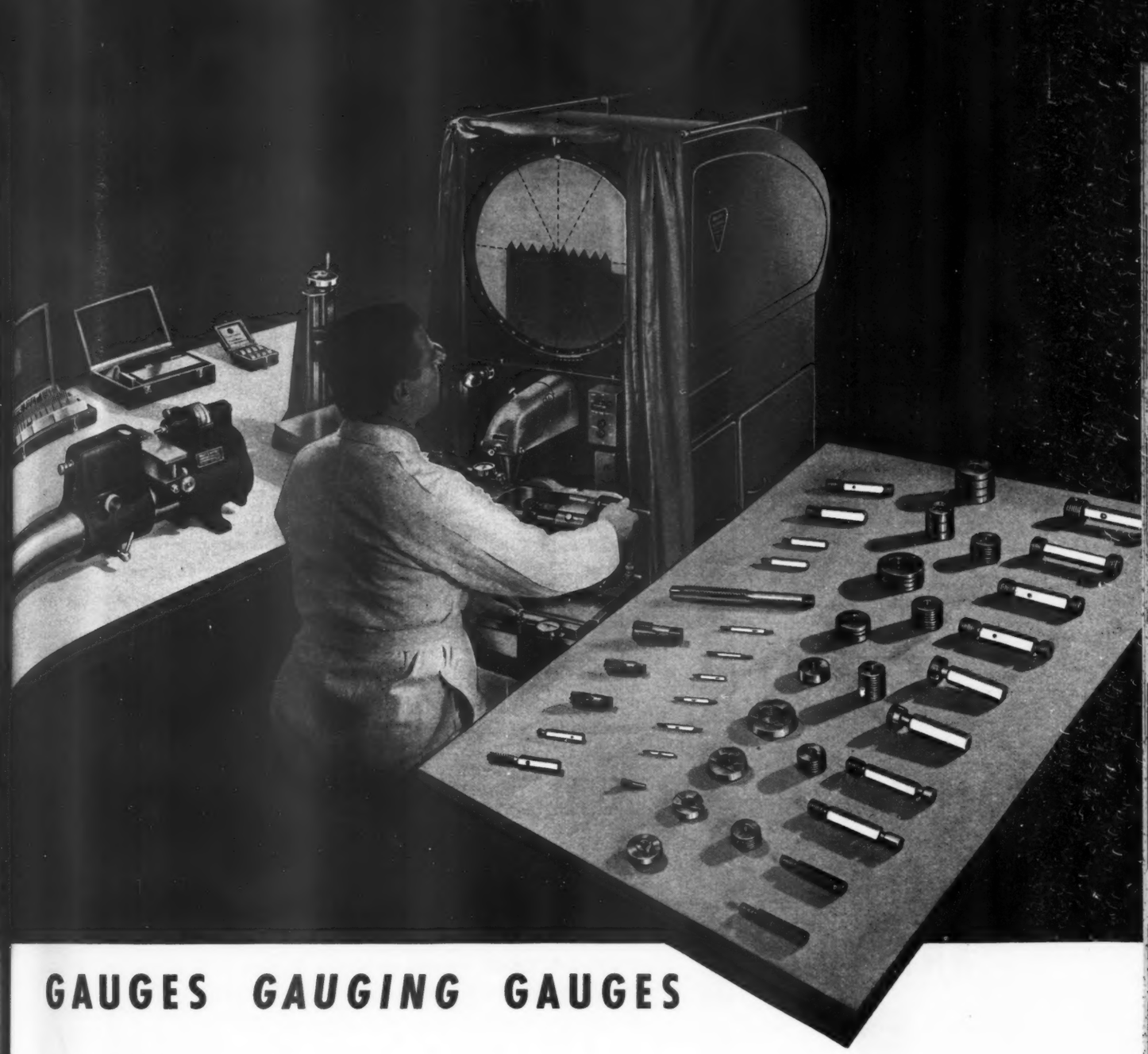
Weltronic power and control units

Complete power and control units for resistance welding are now available from *Weltronic Corp.,* 2832 E. Grand Blvd., Detroit, Mich. Including, in one compact cabinet, contactors and firing relays, sequence timer, protecting fuses, limit switches, motor starter, low voltage transformer and relay, the complete power cabinet eliminates necessity for usual multiplicity of separate control units and all external inter-unit wiring, so that only simplest of wiring is needed to connect complete set of controls to machine. Units are available with wide variety of contactors, ranging up to 600 amp. capacity, with synchronous and non-synchronous types of timers of any standard or special Weltronic type.—AVIATION, *November, 1941.*

A portable fluorescent light, encased in a tube of transparent "Lucite" speeds night work on airplane assembly lines by providing proper illumination for confined and inaccessible areas. Manufactured by *Del-Ray Products,* South Pasadena, Calif., the light is doubly valuable where rushed assembly lines have moved outdoors. It gives off spherical lighting, eliminating shadows in limited working areas, burning cool and emitting daylight-like illumination. "Lucite" was selected to enclose the fluorescent tube because of its good insulating properties, light weight, durability and high light transmission.—AVIATION, *November, 1941.*

Ideal for welding of all light gage metals that are weldable by electric arc, is the claim made by *Hobart Brothers Co.,* Troy, Ohio, for their specially designed arc welder for aircraft construction, called "Aircraft Special". Featuring the "quick, hot start" so necessary to success in welding light gage alloy tubular members, it also provides a lower range of welding current specified from 10 to 150 amperes at normal welding voltage. The "Aircraft Special" welds especially well with coated electrodes of 1/32 to 5/32 in. size, without burning through, and with steady progress along the seam due the "soft arc" that hangs on even under low current conditions. It is said to be ideal in welding X-4130 chrome moly steel on engine mounts. Dual control of current and open circuit voltage enable the operator to select exactly the right volt-ampere combination for each job.—AVIATION, *November, 1941.*

Hobart "Aircraft Special" arc welder



GAUGES *GAUGING* GAUGES

WE are making gauges–testing gauges–out here at VARD. It's interesting too, how circumstances put us into the gauge making business.

As you know, VARD has been turning out some of the finest aircraft hydraulics, navigation plotters, and instruments produced in the United States. We had been buying precision inspection gauges to check our work. But suddenly at the outset of the defense program, we found that inspection gauges were very difficult to secure, especially on the Pacific Coast.

That left us in a fine fix–along with many other manufacturers here.

Fortunately, we had some of the expensive and accurate equipment required by gauge makers, such as, constant temperature rooms, the super-micrometer and comparator, shown above. The comparator, for instance, can enlarge the image of a screw thread 100 times and has means for checking its pitch. With this equipment we could produce gauges.

So, we did make our own gauges.

It wasn't long before the aircraft industry found out that we were making gauges, and the next thing we knew we were in the business.

At present we are almost swamped with orders for cylinder plug and ring gauges, thread plug and ring gauges, and pipe thread plug gauges.

If your company is interested in any of our present products or potential developments, by all means get in touch with VARD.

The VARD trademark on a product symbolizes thorough engineering, the best in materials, and technical, precision workmanship. PASADENA, CALIFORNIA, U.S.A.

VARD MECHANICAL LABORATORY

NO. 8

ALUMINUM, DEFENSE, AND YOU

OCTOBER WAS A MILESTONE MONTH

There have been three other such milestones for civilian uses of aluminum during the past 18 months.

WHEN, ON MARCH 25, 1940, the price of Alcoa Aluminum ingot was reduced from 20c to 19c a pound, it automatically increased the number of civilian applications where using aluminum would be good cost arithmetic.

19¢

Every application carries its own special set of conditions. They determine how much you can pay to save a pound of weight, to get extra heat conductivity, or reflectivity, or what not. 19-cent ingot widened the circle of aluminum's usefulness.

AUGUST 1, 1940 WAS THE SECOND milestone. Economies growing out of greater volume of manufacture, and economies stemming from continuing research, brought the announcement of 18-cent ingot. The civilian manufacturer looking to his future could see, in the offing, more ways to use aluminum than ever before.

18¢

Perhaps you were one of the thousands who filed away in your book of futures the reminder that "when this thing is over, we must figure on using more Alcoa Aluminum."

THIRD MILESTONE showed up almost before you got that note made. November 18, 1940 saw another reduction on Alcoa Aluminum ingot to 17c a pound, making a total reduction of 15% in the midst of a general seller's market.

17¢

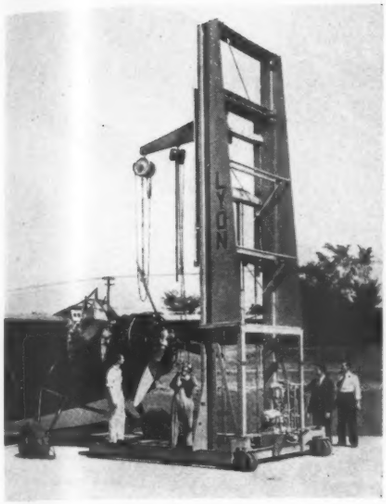
Defense got most of the immediate benefit, but the future of aluminum for you, and you, and you, was writ larger than ever.

THEN CAME 15c INGOT, effective Oct. 1, 1941, with accordant reductions in fabricated forms of Alcoa Aluminum. This means that the arithmetic of weight saving is all new, since last you figured on using this versatile metal in a civilian application. When the emergency is over, the fact is that all your old material cost comparisons will be as dead as a dodo.

15¢

THE ARITHMETIC IS NEW; but the fundamentals just get more so! More than ever, the strong alloys of Alcoa Aluminum are *the* answer to lightness with strength.

ALUMINUM COMPANY OF AMERICA



Lyon-Raymond portable elevator

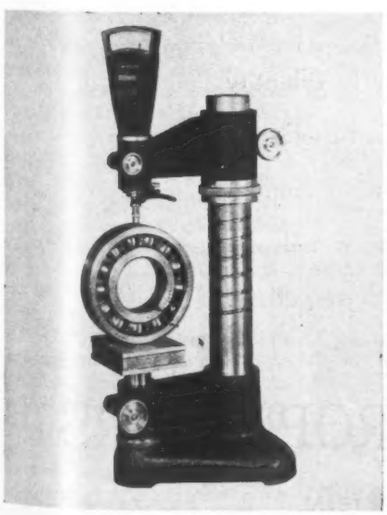
One of the largest hydraulic portable elevators ever built has been announced for the aircraft industry by *Lyon-Raymond Corp.* (formerly the Lyon Iron Works), 839 Madison St., Greene, N. Y. Designed for installing or removing engines on bombing planes, it has a capacity of 5000 lb. A removable platform (not shown in cut) is 6x7 ft. and has a lowered height of 2 ft. and an elevation of 14 ft. An elevating boom, swinging 12 in. each side of center, is operated by a hand chain through worm and gear. Lowered height of boom from floor to center of pin for chain falls is 9 ft. 5½ in.; elevation is 14 ft. Platform and boom are elevated by hydraulic hoist and 3 hp. motor driven hydraulic pump. Elevating and lowering controlled through Solenoid valve operated by "dead man" type controller. Speed of elevation is about 12 in. per min.—AVIATION, *November, 1941.*

An innovation in eye protection is the claim for I-Gards, just introduced by *B. F. McDonald Co.,* 1248 So. Hope St., Los Angeles, Calif., which are said to combine the best features of spectacles and cup goggles with the disadvantages of neither. I-Gards are molded of clear plastic, and because there is no frame surrounding the lens, the device has no expensive parts which makes for an economical price. Although lack of side-pieces affords unrestricted wide angle vision, I-Gards are said to provide the same protection from obliquely flying objects that cup goggles afford. Because the light lenses fit snugly around the eyes, there is no pressure on the bridge of the nose or ears. I-Gards are non-shatterable, withstanding the standard drop test, and are made with clear or green "Vernalite" lenses.—AVIATION, *November, 1941.*

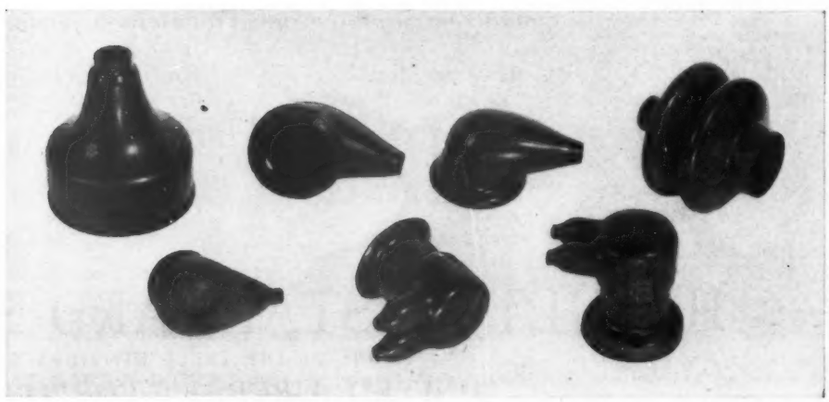
McDonald "I-Gards"

A new heavy duty measuring and inspection instrument, designed especially to handle large and heavy precision work up to eight inches in diameter, was brought out recently by *George Scherr Co.,* 128 Lafayette St., New York, N. Y. Called the Heavy Duty Model 8 Comparitol, it has a 2½ in. diameter column, extremely heavy holder bracket to hold the measuring head, and a 4x4 in. hardened steel, accurately lapped table to handle large work. Base is very rigid and sturdy with three-point contact to guarantee extreme stability. A simple patented knife-edge lever system is used in the mechanism. The Comparitol is being used to check and inspect plug gages, bearings, pins, ball bearings and other parts, and may be obtained with scale reading to .0001 in. or to .00005 in. Instrument is said not to be affected by vibration and may be used under abnormal shop conditions.—AVIATION, *November, 1941.*

Flexible rubber boots used as dust and moisture sealing covers, corrosion resistant protecting caps, and other rubber parts requiring a uniform thin wall up to ⅛ in. thickness, are being produced from both rubber and neoprene by *Automotive Rubber Co.,* 8601 Epworth Blvd., Detroit, Mich., by a process known as form-dipping. Most rubber parts designed with a uniform thin wall lend themselves more readily to this type of production than any other process, it is said. Experimental production parts can be made on inexpensive forms in various wall-thickness dimensions to determine which is most suitable. Production forms are comparatively inexpensive, running in most instances but a fraction of a steel mold. Parts having a maximum elasticity and flexibility, with tensiles up to 5,500 lb./sq. in. are being produced by this process.—AVIATION, *November, 1941.*

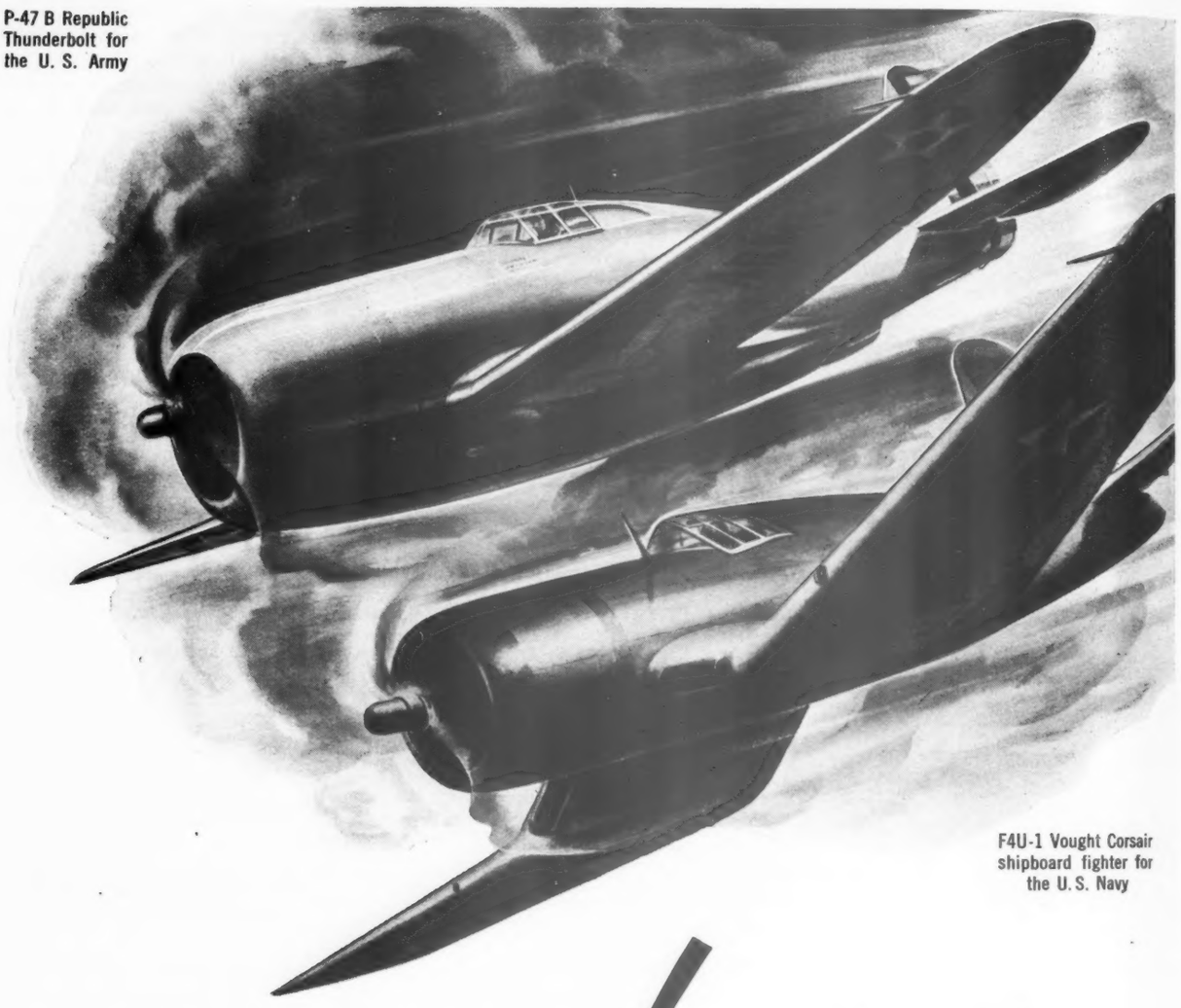


Scherr heavy duty Model 8 Comparitol



Automotive Rubber flexible boots

P-47 B Republic Thunderbolt for the U. S. Army



F4U-1 Vought Corsair shipboard fighter for the U. S. Navy

PROPELLERS for the *fastest*

Two of the world's fastest fighting planes now in quantity production are the Army Thunderbolt pursuit and the Navy Corsair fighter. » » » Like thousands of other combat and advanced training planes, these latest types will be equipped with Hamilton Standard Hydromatic propellers.

HAMILTON STANDARD PROPELLERS

ONE OF THE THREE DIVISIONS OF
UNITED AIRCRAFT CORPORATION
EAST HARTFORD, CONNECTICUT

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington · C. F. McReynolds, Pacific Coast · Randolph Hawthorne, New York · E. R. Lockin, New York

NOVEMBER 1941

SPAB Gives Airlines 228 Planes in 18 Months Designed for Emergency Use by the Air Force

After months of uncertain negotiations with the Government, the airlines now have been allowed, for the next 18 months, a 65 percent increase over their present flying equipment—228 planes in addition to the 350 now in operation. In case of further emergency the lines may not get all these planes, or, if they do, some may be taken away. Nevertheless, issuance of the order by the Supply Priorities and Allocations Board confirms the Administration's recognition of air transport as a major link in the defense program.

For the first time, under this new order, substantial numbers of four-engined planes will be available to the domestic lines, and this is regarded as opening a period of larger units for the long runs.

Meanwhile, in order to make fullest use of existing production facilities and tooling, CAA probably will waive the new airworthiness rules which would have stopped production of most present airline equipment at the end of this year. Thus, the expansion will be accomplished at maximum speed with types now in production.

It is known, however, that several new types are on the drawing boards. Most talked about is the DC-6, which is said to be somewhat larger than the DC-3, has two engines, and is a low wing type. Creditable reports are heard that high-wing planes are being designed, so as to give more space above the ground for larger propellers, to absorb the power of bigger engines.

SPAB ruled that plane manufacturers may accept orders from commercial airlines for 156 DC-3s; 20 four-engined DC-4s; and 52 Lockheed Lodestars. This quota of new planes is equal to more than two-thirds of the airlines' present total of 350 planes. Reasons for this generous increase are: wish of the government to have adequate space on the lines for defense cargo and travel; develop the transport system as a permanent backlog of pilots, planes and plane capacity; to expand the system for better postal service.

But several restrictions are attached to these allocations. One is that the planes are to be designed for quick conversion to military use—that is, they are to have wide doors, reinforced floors, and chairs easily removable. Further, delivery of the planes to the airlines is not to interfere with the output of military types. And, most important, the transport planes are to be subject to call by the Army at any time. In other words the 228 planes are actually on a sort of "purchase-loan" from the army.

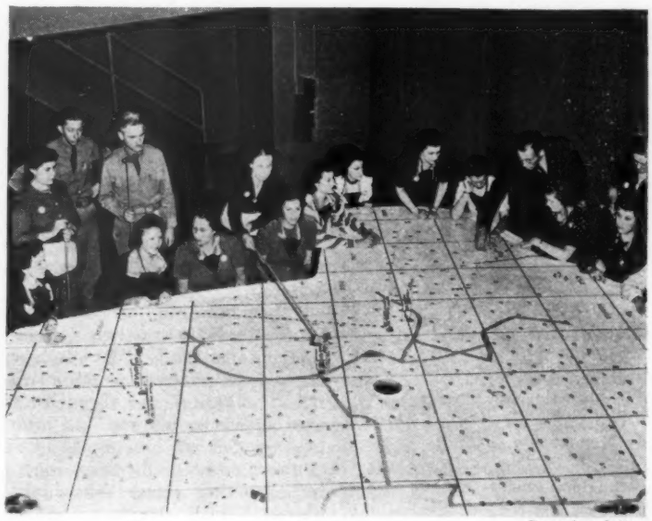
It will be noticed that the Lockheed Constellation was not included in the authorization to the airlines. SPAB took this under advisement and decided that work should continue on the three now being built. The placement of orders would be taken up later.

Orders were authorized on the DC-4 because the Army had

(*Turn to page* 112)

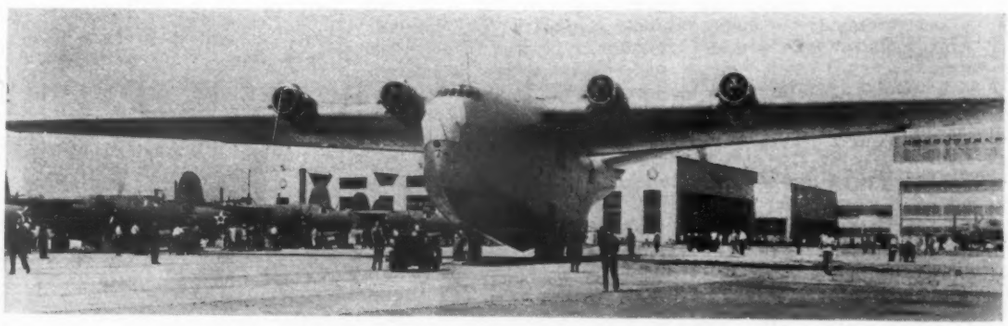
Press Association

VISITORS at New York's Defense Exposition got a big thrill from what they thought was the new Sperry bombsight, shown above. Actually the Air Corps got this out of the Wright Field Museum. It is of a very early vintage, and has little relationship with today's sight.



Press Association

WAR GAMES continue, this time in the Northeast. This is the latest type of "Filter Board" in use in New York City by the Air Defense Command. 40,000 civilians watch for invading planes, report progress to a central telephone exchange, which in turn passes on the information that is plotted on this board.



THE GREAT MARTIN XPB2M-1, world's largest flying boat, will continue to be news for many months. A few facts: 200 ft. wing span, weight 70 tons, four 2,000 hp. Wright engines, range would enable it to fly far into Europe and return to this country. Flight tests will be made soon.

3,775 Civilian Planes Built, First Half 1941

During the first six months of 1941, a total of 3,775 airplanes for civilian use were produced by American manufacturers, an increase of 65 percent over the figure of 2,289 for the corresponding six months of 1940. This advance is attributed by Donald Connolly, CAA Administrator largely to the effect of the CPTP program.

Of the 3,775 total, 2,265 were in the 1-2 place single engine type of from 51-70 hp., and 1,113 in the 71-100 hp., both of which are elementary training types.

In the single-engine 166-225 hp. category, which includes aircraft used in the CPT secondary course, the production in the 1941 period was 105, against only 14 in 1940. Multi-engine output in this class rose from three (3) in 1940 to 25 in 1941.

General Connolly said that the production figures emphasized the continued trend toward more powerful engine installation in airplanes built for private use, another effect of the Civilian Pilot Training Program on the light airplane market.

By Types

	January–June 1941	1940
Landplanes:		
1–2 place:		
Single engine	2880	1786
Multi-engine	0	2
3–5 place:		
Single engine	757	396
Multi-engine	7	3
6–17 place:		
Multi-engine	65	66
Seaplanes:		
Single engines	3	10
Multi-engine	5	0
Amphibians:		
Single engine	0	1
Multi-engine	18	0
Total single engine	3640	2207
Total multi-engine	116	82
Unclassified	19	14
Total	3775	2289

By Horsepower

	1941	1940
50 hp. and under:		
Single engine	10	256
Multi-engine	0	1
51–70 hp.:		
Single engine	2265	1496
71–100 hp.:		
Single engine	1113	290
101–165 hp.:		
Single engine	120	78
166–225 hp.:		
Single engine	105	14
Multi-engine	25	3
226–300 hp.:		
Single engine	9	21
301–600 hp.:		
Single engine	18	37
Multi-engine	1	6
601 hp. and over:		
Single engine	0	1
Multi-engine	90	72
Total single engine	3640	2207
Total multi-engine	116	82
Unclassified	19	14
Total	3775	2289

By Weight and Engine

	January–June 1941	1940
Not more than 1300 lb.:		
Single engine	2328	1411
1301–4000 lb.:		
Single engine	1290	740
4001–10,000 lb.:		
Single engine	22	42
Multi-engine	26	10
10,001–25,000 lb.:		
Multi-engine	85	67
25,001 pounds and over:		
Multi-engine	5	5
Unclassified	19	14
Total	3775	2289

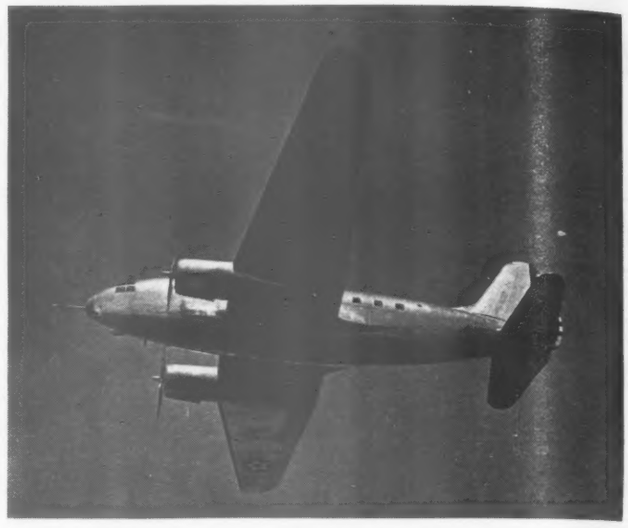
Army Uses Lightplanes

Over two dozen lightplanes were used experimentally by the Army in its maneuvers throughout the South. The reaction was strongly favorable. At the beginning the Army was frankly sceptical, but by the end of the first week the "Grasshoppers" had won the respect and admiration of all who had watched them work.

The Pipers, Aeroncas and Taylorcrafts were used primarily by the various ground divisions rather than by the Air Corps. The small planes were used chiefly for four purposes: to direct artillery fire by radio, do scouting and observation work, carry messages and transport personnel. After ground officers had accepted the fact that the planes were available, plenty of work was found for the Grasshoppers to do.

When hundreds of radio messages jammed the air waves, lightplanes made fast deliveries of important communications, making aerial pick-ups and deliveries as well as landing to deliver messages. One delivery was made to a major in a moving scout car. Lightplanes, with engines idling, were able to hover near enemy troop movements, count the motorized equipment, and report back by radio. Officers as high in rank as two-star generals were transported from base to base—the general in question preferring a one-hour trip by air to a four-hour ride by car over congested, dusty roads. It was found that most landings were made on roads, rather than in emergency fields. The ability of the Grasshoppers to land on a road, taxi up to an ordinary filling station for gas, to be started and flown by one man, was found to be an advantage over heavier observation planes that require four or more men to turn them around and get them going, as well as their need for high-test aviation gasoline.

Pilots who have flown big ships are naturally skittish about anything as light as a Cub, but the infantry points out that the same would be true of a motorcycle.



THE CURTISS-WRIGHT ARMY TRANSPORT, to be called the C-46. This 40,000 lb. ship is largest twin-engined airplane in the U. S. It will be built in large numbers at St. Louis and Buffalo.

CPT Doubles Rate of Graduating Instructors Students "Joining Up" Average 916 per Month

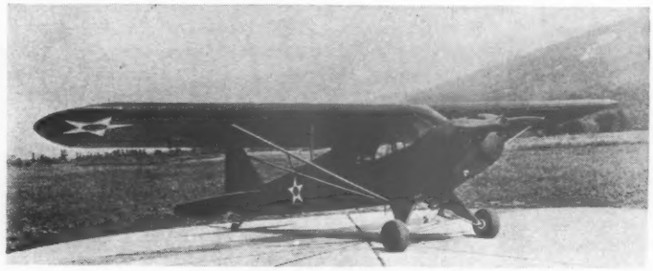
Washington DC:—Flight instructors are being turned out by CPT at almost double the best previous rate says CAA.

Flight instructors have been going to the Army, Navy, Canadian Air Force, and the airlines at the rate of 219 a month since June 1, as compared with the three-month average of only 112 a month previous to June 1. CAA student pilots have been answering defense calls at the rate of 916 a month since the first of June, well ahead of the previous three-month average of 863. A grand total of 12,079 students and instructors have joined the defense effort since the CAA pilot-training program began, General Connolly stated.

These instructors have all gone through the CPT elementary, secondary, cross country and instructor classes of the program and are now working either at the civilian schools where the Air Corps is having cadets trained, at schools of the Canadian Air Force, as active members of U. S. Air Corps and Navy forces, or as co-pilots on the nation's airlines. Most of the latter replace airline pilots who have been called by either the Air Corps or the Navy.

As of March 1, a total of 941 CAA-trained instructors had entered service; by June 1, there were 1,279 and by 1st of September, 1,916.

By March 1, a total of 4,813 CAA-trained students had entered the military services. By



THE PIPER YO-59, delivered to the Air Corps recently. Taylorcraft and Aeronca are also delivering military light-planes.

June 1, there were 7,403 and by September 1, 10,153.

In all, 65,343 students have enrolled in CAA pilot training courses, of whom 52,084 students have completed the various courses since the summer of 1939. Of these, a total of 7,064 have taken refresher and instructor courses, 38,475 have taken elementary courses, and 6,545 have taken the secondary course. Most of the instructors coming out of recent classes have come from graduates of previous secondary courses, which means that boys who had never flown before have been trained from their first flight up through the intensive courses which have made them competent to train others.

President Appoints Aeronautical Commission

Members to represent the United States on a Permanent American Aeronautical Commission were recently appointed by the President under a resolution adopted by the Inter-American Technical Aviation Conference held in Lima back in 1937.

Following established policy in Latin American affairs, the President refrained until now from creating the U. S. wing of the commission until it became clearly evident that the other American republics were actively interested.

Although created primarily to codify international air law, it is expected that the commission will play an important part in Western Hemisphere air defense plans.

NAA Snubs Nazis

The Board of Directors of the National Aeronautic Association, meeting in Detroit early last month, was gratified at the management's report of a 70 percent increase in membership over the past year and in a sound financial position without outside contributions.

Meanwhile, NAA is campaigning for establishment of college flying clubs as chapters of the NAA affiliate, the National Intercollegiate Flying Club. Also, another NAA affiliate, the Academy of Model Aeronautics, convening in Pittsburgh, laid plans to encourage federal recognition of model building and flying as a defense training activity.

The Contest Board, headed by Dr. George W. Lewis, decided on a polite refusal of a request by the Federation Aeronautique Internationale—forwarded to NAA through the Aero Club of Germany—to forward the helicopter duration record established last May. NAA has previously offered its Washington facilities for the safekeeping of FAI records during the war period.

Nazis took over FAI upon the fall of Paris.

No Irate Witnesses

Washington's aviation circles went agog lately when word went out that the Civil Aeronautics Board would hold hearings on a proposed regulation requiring all civil aircraft pilots and aircraft to be certificated by the federal government. Under present law, as for years past, pilots and planes may operate within their own states without a federal certificate. If the state in question does not require a certificate, then the pilot and plane could sail around, intra-murally, with only the sky as a limit.

At last comes the big day that all American pilots are to be regimented! People had talked about it since youngsters could remember. And what happened? Nothing. Just a few letters of objection. No irate witnesses. No screams of pain. It just crept up, like hemlock.

Private Flyers in CAD

Plans for a Civil Air Defense program enlisting private flyers into an active defense auxiliary under LaGuardia's Office of Civilian Defense are moving forward rapidly with an official announcement expected as this was written.

The "Little Flower" has been keeping his plans very quiet in order to have all organizational details completed and instructional pamphlets printed before springing a sensational announcement.

Meanwhile, the NAA has been busy encouraging private flyers to form into local groups ready for cooperation with LaGuardia when the national program becomes effective. Definite action has already been taken by 17 states, under the sanction of state governments, and squadrons formed in additional states pending official approval.

Morrow Plane

Test flights of the new plastic plywood Morrow training plane were made October 5, with Vance Breese at the controls. A substantial production program is to be inaugurated upon completion of the flight test program. The factory of Morrow Aircraft Corp. is located in San Bernardino, Calif.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Crime Does Not Pay

The Norden bomb sight which the German spies stole was an older model, we are informed, basically different from the present one, which they *haven't* stolen. Incidentally, the superiority of new American bomb sights is that they enable the bombardier to aim without putting the airplane in a straight run, which would lay it open to enemy fire. Incidentally, again the new "predictor" for aiming the guns of a tank while it is in motion, works on the same principle as the airplane bomb sights.

Separate air force talk has subsided for the time being. Officers here are telling how the Germans send navy officers on tours of land and air duty, army officers to sea, air officers to both, etc. They are saying that war operations involve coordinated effort of all arms; that jealousy between the arms is deleterious; that maybe high-up warriors should be neither Army nor Navy nor Air, but over-all war experts. Just something to think about.

Most secret device in a war now is the plane-borne locator. The courses of attacking groups and defenders are again and again plotted to their intersection and then one or both groups fail to see the other. If the plane borne locator can be made to work it will make a great change in air tactics.

The Stubblefield Award goes to the Edmund C. Heine, alleged Nazi spy, who admitted through his attorney, in a court trying 16 others, that he had forwarded a report to Germany saying the United States would be building 1,000 planes a day by the end of 1941.

Conversation with the British Embassy: "Hello, is Air Commodore Thornton there please?" "No." "Will he be in soon?" "No." "Will he be in today?" "No." "Then when will he be in, please?" "Perhaps tomorrow." "Is there any one who could speak for him now?" "I don't think so." . . . Put that in a British accent, and try to lease or borrow fourteen billion dollars worth of airplanes and stuff from your rich cousin. How do they do it?

North to Russia: Reports came out of the Anglo-American-Soviet war conference that a U. S. ferry service would be established between here and Siberia via Alaska. This was predicted in the Windsock of last August. Such a line seems probable if the Russians stay in the war—certain as a peacetime project eventually.

The "No Show" advertising campaign of the airlines is making the passengers self-conscious. Nobody wants to be a dirty name. Customers making reservations, without being asked, assure the airline desk they will call back as soon as they know for sure.

A nice trick, if you can do it, is to fix up a "defense travel priority card," and get somebody else put off the airlines so you can get on. It's been tried, but it hasn't worked yet, we are told. All defense officers here, and CAA, tell this column that no such card has been issued.

Murder at the National Airport in Washington would rekindle the 100-year-old controversy over whose land it is, under whose jurisdiction. Meanwhile, you can't get a drink out there till they decide whether Maryland or D. C. should issue the license.

(*Continued from page* 109)

already taken over the original airlines' order for 61, and Douglas had tooled up a production line, which has nearly completed the first ships. The 20 for airlines are in addition to the Army's 61. The original DC-4 was flown around the country, and sold to Japan, where the little men cracked it up. Then a smaller plane was designed, which is the one now in production.

The CAB time limit on airplanes that do not meet the "04." airworthiness requirements, in effect, says that such planes cannot be bought and put into operation after the first of the coming year, and that they cannot be flown after the first of 1946. But if the Board suspends this ruling, as is now indicated, all present types can be bought and flown until further notice or until such new date as may be set. Of course the CAB regulations do not affect planes for the Services and for export.

The 04. performance specifications deal with all flying characteristics: time and length of take-off, landing, approach, control, trim, etc. One of the main considerations of the Board, in writing the rules, was to get a plane that would continue safe flight, with one inoperative engine, in any circumstances. Another aim was to get a plane in which there never would be any deceptive stick force, or lack of it, at various speeds and near-stalls. Ship should stall without rolling, or excessive pitching. CAB wanted to open the way for three-wheeled undercarriages, too; the old low landing speed made the two-wheel type almost mandatory. Of course part of those regulations can be retained and others changed for the duration.

Pipers on Mail Line

Light planes will be used for the first time for regular scheduled air mail service—four Piper Cub Cruisers recently delivered to the Dominican Republic.

Selected by Col. C. A. McLaughlin of the Dominican Army, it is understood that the ships will be used to operate out of restricted airports in sections of the country where ground travel is slow and uncertain. Exact routes have not been disclosed.

With 25-gallon gasoline capacity allowing a range of 450 miles, the planes will carry mail only. Removal of the rear seats and installation of a special cargo bin will allow a 340-pound mail load.

CALLING NAMES

Marshall C. Hoppin, superintendent of airways in Alaska since 1939, is appointed manager of the new CAA Region VIII—Alaska.

Walter J. Moxom takes over two jobs at LaGuardia Airport—senior meteorologist and acting regional director of Weather Bureau's new region No. 1.

L. A. Smith replaces **W. T. Childress** as treasurer of McDonnell Aircraft Corp. and continues as comptroller and secretary. **Edgar E. Rand** is elected a director.

Henry L. Knight, formerly attorney examiner of CAA, joins the Aeronautical Chamber of Commerce.

Peter Altman of Vultee is SAE nominee for Vice-Pres.—Aircraft; and **C. F. Bachle** of Continental Aviation & Engineering is nominee for Vice-Pres.—Research.

Donald G. Dunn, sales promotion and advertising manager of Reynolds Metals is appointed assistant to Vice-Pres. **J. Louis Reynolds.**

Maj. Gen. Adna R. Chaffee, who died in August, is honored by War Dept. by naming of new camp near Fort Smith, Ark., "Camp Chaffee."

N. B. Rader named San Francisco District traffic manager for UAL as successor to S. A. Stimpson. Following his resignation, Mr. Stimpson said he would announce his future plans later.

Charles Froesch, chief engineer, EAL is elected to represent the air lines on the Council of the Institute of Aeronautical Sciences, succeeding Ralph Damon, now pres. of Republic Aircraft Corp.

W. P. English, formerly assistant to v.p., is appointed assistant v.p., TransCanada.

Time is sending its air express edition to Iceland by U. S. Navy patrol plane.

Lt. Eugene F. Zimmerman, USNR, Aviation Department, Shell Oil, goes on active duty with the new Production Section of the Bureau of Aeronautics.

Grove Webster, chief of the Civilian Pilot Training program since 1938, resigns to re-enter aviation business.

Corrington Gill is named by Mayor LaGuardia as deputy director in charge of operations of the Office of Civilian Defense.

Kendall G. Hathaway replaces **Robert M. Love** as president of Inter City Aviation. Mr. Love remains chairman of the board.

Maj. Gen. Frank M. Andrews is advanced to rank of Lieut. Gen. as head of Caribbean Defense Command and the Panama Canal Dept.

Capt. Gill Robb Wilson, director of Universal Air Freight Corp., was guest speaker before Women's Traffic Club of N. Y. on Oct. 14.

J. Alden Rigdon is appointed general manager of Aircraft Plywood Div. of Goshen Veneer Co., Goshen, Ind.

J. S. Knowlson, president of Stewart-Warner, is named Deputy Director of Priorities of OPM, in charge of operations.

John Brooks, asst. production mgr. in charge of customer contacts at AC Spark Plug Div. of General Motors, is loaned to the British Purchasing Commission as an adviser on planning and production.

Ralph P. Bell, director general of aircraft production for Canada, was chief speaker at National Industrial Advertisers Assn. convention.

Reay Jones and **Ed M. Lepper** of TWA are promoted respectively to assistant personnel manager and system chief clerk.

Charles L. Nielson is appointed assistant controller of Fleetwings, Inc., assisting **I. S. Wilson.**

A. D. McLean is named Controller of Civil Aviation in Canada.

Assistant Secretary of the Navy for Aeronautics Artemus L. Gates will have a personal flag similar to that of the Secretary of the Navy, except the design will be in red on a white field, and will have the same personal honors as the Assistant Secretary of the Navy.

Bruce K. Craig, test engineer killed in a bomber crash on June 2, is honored by War Dept. through naming of Craig Field at Selma, Ala.

Capt. John S. Delano, president of American Pilots Association, is elected to his fifth two-year term in that office. **Capt. Robert McBride** is reelected vice-pres.

G. Hall Roosevelt, who died in September, was an instructor of pursuit-plane flying in the World War, first at Gerstner Field, La., and later in Florida. He designed an early successful pursuit plane and taught many youths to fly pursuit craft.

Maj. Gen. Gerald C. Brant is assigned to command the Newfoundland Base Command, succeeding **Brig. Gen. Henry W. Harms,** who will command the Air Base at Pendleton, Ore.

Capt. Elliott Roosevelt is taking instruction in aerial navigation at Kelly Field, and upon completion in December, will be entered in the aircraft observers' course at Brooks Field.

Dr. Howard K. Edwards is appointed director of the aero-medical department of Eastern Air Lines, and **John C. Ray** is named superintendent of the motor department at Miami.

Walter Innes, Jr. is elected chairman of the board of Aircraft Components.

Jack Fontaine, recently chief engineer of the Stinson Division, takes over the important post of chief engineer of Vultee Aircraft at Nashville. **Alex Tsongas** is appointed acting chief engineer of Stinson Division. Chief engineer **E. G. Bruce** heads the newly combined aerodynamics, structures and general research departments as chief research engineer.

G. H. Macomber, asst. traffic manager for United Air Lines, was named national aviation chairman for the U. S. Junior Chamber of Commerce.

A. Ross Miller is made director of plant protection for North American Aviation.

Arthur W. Nelson, Army pilot, is added to the flight research staff of Bell Aircraft.

Don H. Revell has been made general factory manager of Fairchild Aviation; **A. S. Blumenthal,** general factory superintendent; **Phil I. Harr,** production manager; and **Louis Fahnestock** quality and liaison engineer.

Coolidge Sherman is named eastern sales manager of Allegheny Ludlum Steel.

James W. Parker, vice-pres. and chief engineer of Detroit Edison Co., is elected president of American Society of Mechanical Engineers.

John F. McKernan, recently in the production division of OPM, returns to Western Electric as manager of defense program planning.

George L. Price, formerly with Bell Aircraft, goes to Los Angeles as West Coast representative of General Engineering Co.

Ray P. Tennes is elected chairman of the board of Shafer Bearing Corp.

Louis B. Neumiller is elected president of Caterpillar Tractor Co.

James L. Goddard takes on industrial relations department of Plomb Tool Co., Los Angeles, Calif.

Charles Cresswell, for 20 years Chief Army Inspector at Boeing, is transferred to Douglas.

Elmer Eggleston, Robert Kerr and **Thomas Endres** receive 20-year service pins from Boeing; **Frank Fourmont** receives 15-year emblem.

E. O. Cocke, appointed sales mgr. of TWA at Kansas City, is succeeded as regional mgr. at Pittsburgh by **C. E. McCollum,** who is succeeded by **Louis Marechal** as Philadelphia traffic mgr. **Wally Smith** is appointed district manager of newly created Honolulu territory. **Luther Hoffman** is appointed electrical engineer.

Leslie B. Cooper joins the sales department of Kellett Autogiro and **H. D. Guy** joins as factory superintendent.

WHEN YOU PARK your private plane at John Groves' Washington Airport you get a free scooter ride with your baggage to the terminal. There is no charge for landing but you pay $1 for overnight parking privileges. Radios are necessary.

DIETZGEN

DIRECTO

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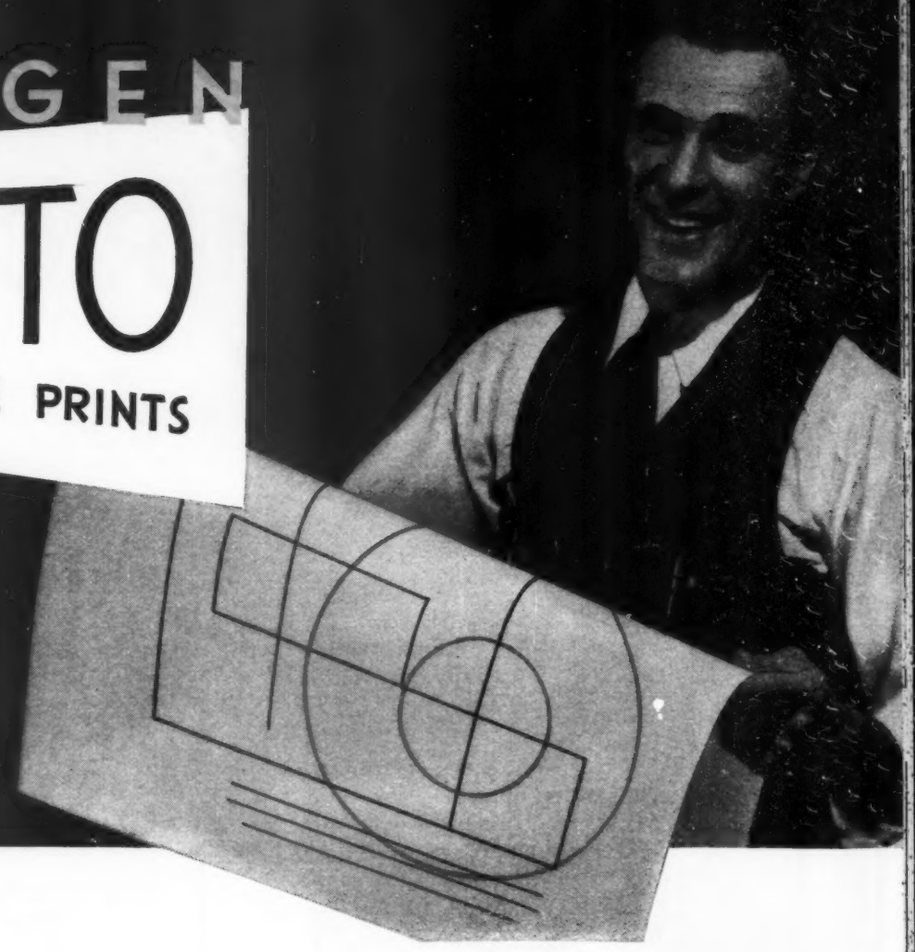

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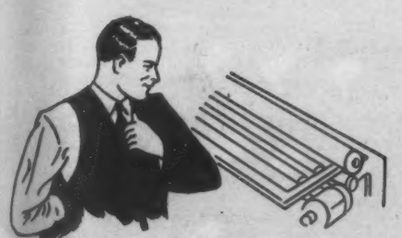

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Dietzgen Directo prints have blacker, denser lines, and whiter, clearer backgrounds. They are easier to read, and reading is more accurate. There is less chance of any mistakes, less chance for mental upsets. Directo prints are more permanent than any black and white print you have seen before. They serve you longer, save you the trouble, cost and time of making new prints prematurely. Your operator doesn't have to worry about variations in development speed. Directo prints are of uniformly high quality *always* and Directo paper is *faster* than your operator can work. Still another important saving: the developing solution won't deteriorate. You don't have to clean your machine daily, don't have to rebottle the solution. Simply leave the solution in the machine and add to it as it is used up. No discoloration, smearing or fading.

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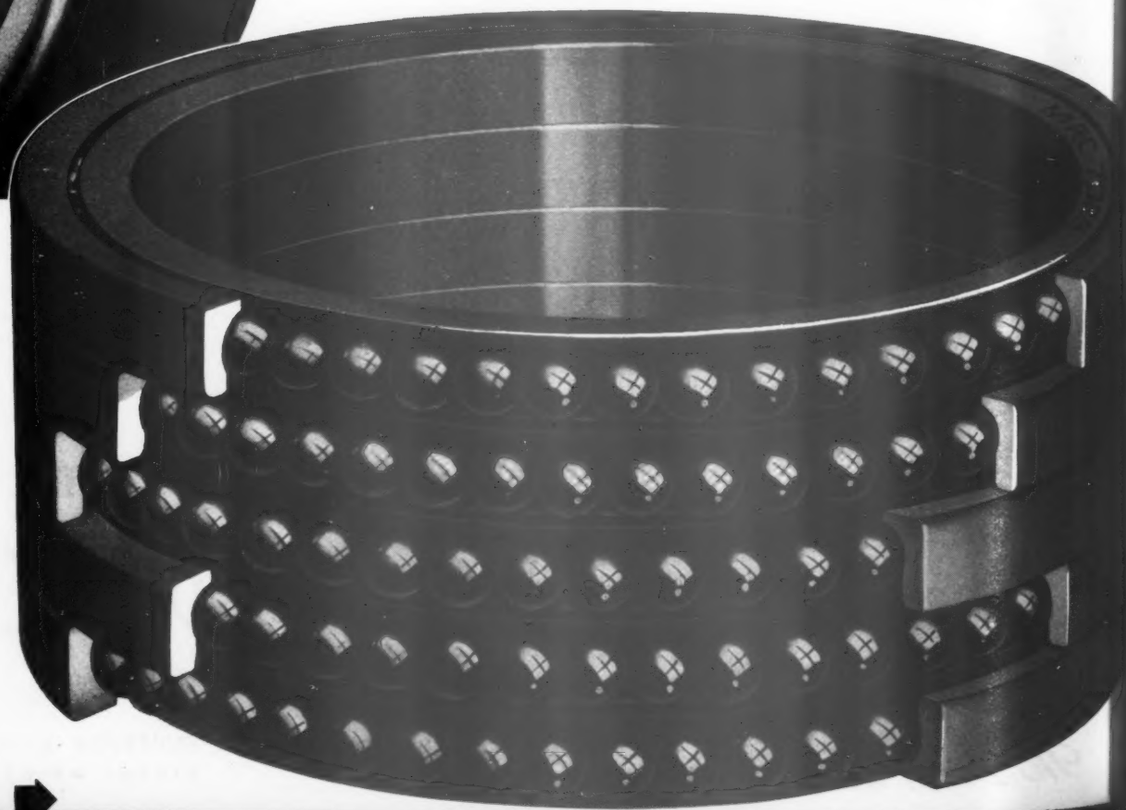
Wright Aeronautical Corporation . Paterson, N. J.	*Engines*

MARLIN-ROCKWELL CORPORATION

Executive Offices . . . Jamestown, N. Y.
Factories at Jamestown, N. Y. and Plainville, Conn.



New Roller Bearing of advanced design developed by M-R-C for use on crankshafts of aircraft engines. Wright-Aeronautical and other prominent engine manufacturers use this type of M-R-C Roller Bearing.

M-R-C "stacked" blade bearing is one of many different M-R-C bearings used in the Curtiss Electric Propeller, and is capable of carrying a thrust load of over 200,000 pounds. This bearing was especially developed by M-R-C in close collaboration with the Propeller Division.

Army and Air Force "Defend" East Coast

The Eastern Seaboard from Boston to Norfolk witnessed the first active test of a permanent system of air defense that is being worked out for the entire United States when the first Air Force Air Defense exercise was held October 9-16 with civilian observers joining with Army planes and anti-aircraft regiments in routing a mock enemy air raid.

The system envisions "a protective blanket of steel and light that could be thrown over metropolitan centers" in case of attack from the air.

The entire area was divided into regions with Information Centers in 6 of the large cities and Filter Centers—where preliminary reports were collected—in additional strategic locations. These were under the Interceptor Command.

Both 3-inch gun batteries and 37 mm. anti-aircraft guns were scattered throughout the area, with searchlights located nearby ready to spot "enemy" bombers.

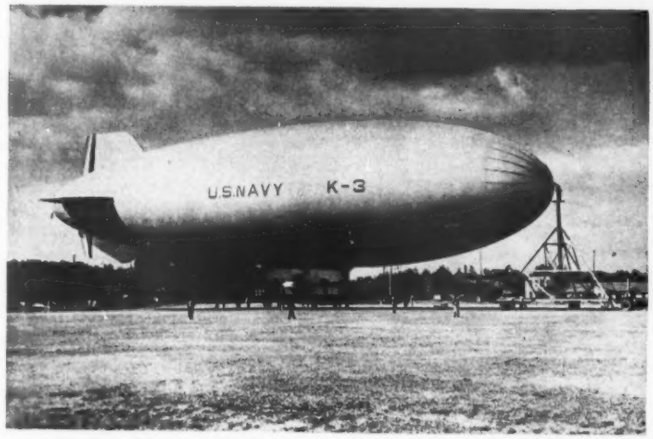
The military forces were aided by almost 40,000 civilians of the Aircraft Warning Service, leaving scarcely any area of the skies unwatched, all linked by an intricate communications net which required only about 50 seconds of elapsed time between observations in the field and the Operations Board.

About 400 planes of all combat types travelled close to a total of 2,000,000 miles over the 1800 Observation Posts. Civilian observers, when a plane was spotted, phoned its type and direction of flight in to the filter centers where the course of the plane was plotted on maps, the information centers notified, and orders issued through the operations board to defending fighter squadrons, anti-aircraft and searchlight batteries and balloon barrages.

The maneuvers were held under the direction of Maj. Gen. Herbert A. Dargue, Commander of the First Air Force operating in the Northeast as part of the Air Force Combat Command under Lt. Gen. Delos C. Emmons.

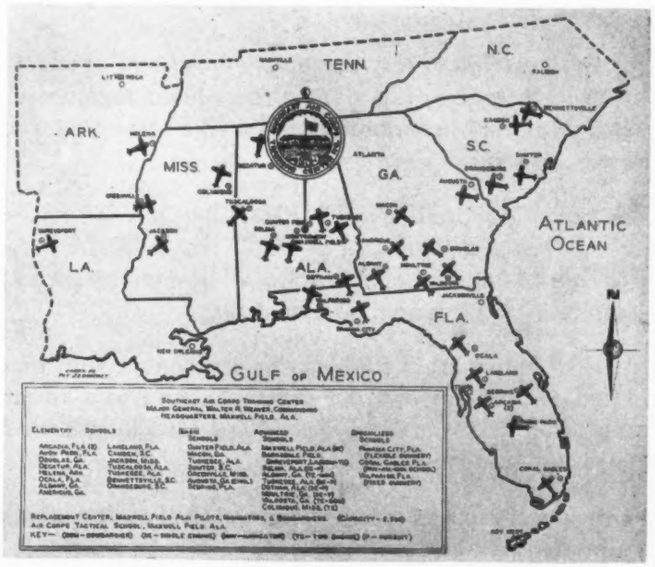
Republic Bars Field

At the request of Republic Aviation Corp., the CAA has issued an order closing its flying field at Farmingdale, Long Island, to private and casual flying. Republic explained the action was necessitated because it is busy throughout the daylight hours testing P-43 Lancers and P-47 Thunderbolts for the Army Air Forces, production of which has increased several hundred percent in recent months.



International News

WORLD'S LARGEST non-rigid airship, built by Goodyear at Akron, is shown following the Navy acceptance flight. The ship is the first of six, is 246 ft. in length, will be equipped with machine guns, torpedoes and depth charges. Cost is $325,000.



AN AIR CORPS TRAINING CENTER is not just one field. This map shows the widespread activities of the Southeast Training Center, headquarters of which is at Maxwell Field, Alabama.

PAA Transports Army Engineers

The largest mass movement yet undertaken by commercial air transport was begun in early October by Pan American Airways which is transporting 727 Army technicians from the U. S. to the Canal Zone over the coming three months.

Through arrangements with the Army Corps of Engineers, the movement is being carried out by the addition of a special section to PAA's regular daily service between Brownsville and the Canal Zone. Detailed transportation schedules have been worked out so that the skilled workmen will arrive as their services are needed on various Army projects, particularly the duplication of the Canal locks.

40 mm. Bofors AA Gun

Fast firing, rugged, capable of being aimed in any direction from straight up to 5 degrees below horizontal, the new 40 mm. Bofors automatic field gun is the Army's deadly defensive weapon against low-flying aircraft.

The rate of fire is 120 to 140 rounds per minute, but usually the bursts are only four or five rounds, after which corrections in aim, if necessary, are made. Reflection sights make it possible to track the enemy aircraft and keep up point blank fire. With a muzzle velocity of 2,850 feet per second, the projectile can be fired in a virtually straight trajectory up to 3,280 yards. It has a maximum range of 11,000 yards, horizontal.

Its sensitive nose fuze will go off if it hits even the thin fabric of an airplane wing, exploding the charge in 15/10,000 of a second. If the projectile misses its mark, it explodes automatically in the air.

Bomber Commands Formed

Creation of four bomber commands—one for each of the four air forces—substantially completes the organization of the new semi-autonomous Army air service. Combat side of the Army Air Forces is divided into four air forces, each assigned to one quadrant of the country. Each air force is made up of an interceptor command responsible for downing enemy bombers, a support command to cooperate with ground troop operations, and one of the new bomber commands to carry out independent missions. A fifth support command is attached to the Armored Force.

The bomber commands take the place of the old bombardment wings.

TWA Trains Crews For AC Ferry Command

Training of four-engine aircraft crews for service with the Air Corps Ferrying Command is undertaken by Transcontinental and Western Air, under a contract with the War Department.

Training will be at the contract flying school of TWA at Albuquerque, New Mexico. Under the contract the cost of instruction is not to exceed $599,760.

Five-man crews, consisting of a pilot, co-pilot, navigator, flight engineer and radio operator, chosen from the personnel of the Ferrying Command will receive a month's training to qualify them for operating the big planes.

PRIORITIES

Hit Leadership First

▸ This is quite natural as leaders generally build more and consume greater quantities of materials. After a time, if raw materials cannot be kept flowing into receiving rooms, there is bound to be a change in production methods and material specifications.

▸ For the past few weeks our engineering and production of light aircraft engines has been stream-lined to meet current control of material production and at the same time produce a better air-worthy product.

▸ The policy of Continental Motors Corporation has always been to "Keep on building better." Therefore, it is utterly impossible to think of substituting inferior materials in order to maintain high production schedules.

▸ Many of our good customers are confronted with the same problem and understand our position. And as a result they realize the high standard of quality in Continental Red Seal Engines is being maintained.

▸ Some purchasers of planes due to this period of change have made deviations in their orders to take what was available. Insofar as Continental is concerned, we are sorry we were not able to serve any customers that could not get their desired delivery.

▸ At this time we are happy to announce that we are once again on regular production schedule and that every engine part is the same high quality of material and workmanship that is responsible for making "Red Seal Engines" famous.

Continental Motors Corporation
MUSKEGON, MICHIGAN

Keeping Pace with Defense...Keeping Faith with Customers

Plane Exports Shift Towards Heavy Types

Although the number of planes being shipped to the British dropped steadily after April, dollar value and poundage has been rising. In April, nearly 600 ships went overseas, while in July—the last month for which official figures are available—only 360 planes were shipped, with a total value of $33,529,000.

What is happening, of course, is that our bomber production is going to Britain, and, as total output increases, the number of planes as well as tonnage will begin rising again. It is unofficially estimated, in fact, that August exports were probably close to 500. Deliveries to Russia of light types will probably raise the September figure even farther, perhaps to 700.

Meanwhile, more and more of our aeronautical exports are in the form of finished planes. Last spring large quantities of engines (a thousand in March), propellers, and parts were shipped. By July shipments of crated engines were down to 298, worth $3,838,000 and exports of propellers had all but disappeared, dropping to $764,000.

Only an insignificant portion of airplane exports have yet been handled under lease-lend. As of the end of August, lease-lend shipments amounted to fifteen or sixteen heavy bombers, a score of trainers, and some of the transports taken over from the airlines. The 2,700-odd planes shipped to Britain between passage of lease-lend and the end of August were applied against existing British contracts and are being paid for out of British assets in this country.

Of the more than two billion dollars provided for aeronautical products in the first seven-billion lease-lend appropriation, about $1,300,000 has been allocated to financing the expanded heavy bomber program, of which nearly a billion is now under contract. Rest of the money is scattered thinly over lighter types of craft, spare parts, engines and propellers, and miscellaneous equipment.

The second lend-lease appropriation includes only the comparatively insignificant sum of $685,000,000 for aircraft. This will be used in the main to pick up deliveries to Britain of lighter types as the present contracts run out.

Intercontinent Busy

The new Intercontinent plant at Miami will employ 1600 men by the end of next month, most of whom were recruited locally. The firm is doing sub-contracting for Vultee and for other manufacturers. Backlog now is over $5,000,000. Many of its employees are men who had retired and gone to Miami to relax in peace, but who have wanted to get back into the harness again. Several hundred skilled craftsmen have been recruited from these older men.

New DeLuxe Cruiser

Largest ship of the Piper line, the DeLuxe Cruiser, has been announced by Piper Aircraft Corp. to meet growing need of a low cost 3-passenger private plane.

While primarily the same airplane as the Piper Cruiser, the new DeLuxe model has been improved in appearance and comfort. Most noticeable improvement is 2-tone paint design featuring a hand rubbed finish. Standard equipment includes dual ignition, engine starter, oil radiator, parking brake, dual hydraulic brakes, dual controls, navigation lights, battery, full swivel tailwheel, 4-ply tires and compass. Ship is powered by either Continental 75 or geared Lycoming 75 hp. engines. Gasoline capacity is 25 gal., giving ship a cruising range over 450 mi.

Plans for the merger of Lockheed Aircraft Corp. and its 50 percent owned subsidiary, Vega Airplane Co. were announced October 10 in a point statement issued by the two companies. The plan contemplates issuance of one share of Lockheed stock for each three shares of Vega stock.

Lockheed has subcontracted to Vega a large order for manufacture of bombers for the British Government. This contractual and other considerations make it desirable that the Vega name and identity be preserved. Therefore it is expected a new subsidiary wholly owned by Lockheed will be formed to carry on the business of the present Vega company.

Plan of the merger has been mailed to shareholders of both companies. It must be approved by the holders of not less than two-thirds of the outstanding shares of both companies.

Curtiss-Wright Corp. declared a dividend of $1 a share on the common stock payable Oct. 30. An initial dividend of 50c a share was paid Dec. 14, 1940.

Profit Limits Under Study

Some new form of profit limitation on defense contracts will probably emerge from the investigation of defense profits undertaken by Representative Vinson's naval affairs committee and the public hearings which are to start this month, but few observers in Washington see any chance for immediate passage of the drastic profit-limit bill which Vinson introduced this month. Vinson's bill would limit profits to seven percent of cost on any defense contracts — including sub-contracts and any other contracts that the President decides are defense contracts. Cost is very strictly defined—excluding, for instance, dues, entertainment, and publicity and advertising expenses.

Something like the Vinson bill may however get serious consideration in future months. It is possible however that any legislation finally passed will affect all business rather than subjecting defense business to special burdens. Most likely occasion for passage of really stiff profit controls next year will be if administration plans for voluntary control of wages break down and it proves necessary to legislate wage ceilings. This would build up irresistable pressure for like limits on profits. Correspondingly, the administration right now will probably frown on really drastic profit limits for fear it would result in wage legislation.

On the heels of recent "wage stabilization" action by major Southern California aircraft

GROUP OF AVIATION EDITORS AND WRITERS who visited plants of Bell Aircraft to see the latest methods of Airacobra production. This photo was taken following a formation demonstration flight of three Airacobras at Niagara Falls Municipal Airport where the new Bell plant is duplicating the Buffalo plant production of P-39's. Pres. Lawrence D. Bell (fr. center, black hat band), and other executive personnel of the company, including O. M. Woodson, ass't gen'l mgr.; Rob't J. Woods, ch. design eng'r; Capt. Harry Collins, v.p.; Lester Benson, factory mgr.; Albert Hapke, adv. mgr. Arrangements of tour were under the able direction of Fred R. Neely, Washington representative of Bell and Walter Bonney, public relations. Included in the Washington delegation were Lt. Col. Arthur I. Innes, Air Corps information section, and Lt. Col. Lovett, War Dept. public relation branch. Editors of all eastern aviation magazines were present as well as most eastern aviation writers.

builders a similar move has been made by Gilbert G. Budwig, president of Aircraft Components, Inc., of Van Nuys, Calif. Budwig's firm has granted wages which match the new aircraft scale at all points. But whereas the prime contractors can pass their added wage costs on to the government in many cases, there is no such provision to cover higher wage costs to sub-contractors. In the face of this situation Budwig is seeking to establish a precedent by asking to be re-imbursed by the prime contractors for his higher labor costs. All regular invoices for completed orders are accompanied by another invoice stating the added labor cost due to the new wage scale. All subcontractors are watching the situation closely since no provision has been made to date to protect them against loss resulting from higher wage demands brought about by the stabilization effort on the part of the prime contractors.

Northrop Aircraft, Inc., celebrated the second anniversary of ground breaking for its Hawthorne, Calif., plant by comparing the present backlog of $75,000,000 with the previous condition of no backlog and no factory just 24 months ago. Northrop is now said to hold large contracts for a sensational new type flying wing military plane, to be built in several models, but no information has been permitted for release by the War Department.

Facilities of the Harlow Aircraft Company, Alhambra, Calif., have now been made available for sub-assembly work for other aircraft firms, according to E. M. Allison, president. Harlow is currently in production on the PC5-A tandem trainer of all-metal type and also has under development a larger metal training plane to be introduced shortly.

ASSEMBLY LINES

By Robert Colbora

September production of 1914 planes surprised everyone by surpassing August's 1,854-plane output. A gain of sixty planes may not look impressive, but it must be remembered that September had three fewer working days and that August figures were inflated by some 100 ships substantially completed the previous month. Allowing for these factors, daily productivity in September registered a 2 percent gain over the preceding month, as compared with a 0.6 percent July-August gain on the same basis.

FAIRCHILD AIRCRAFT dedicated a new plant adjacent to the Hagerstown airport recently. Many notables were present including, left to right, Sherman M. Fairchild, Armand Thieblot, Air Commander R. O. Jones, Air Marshall Roderic Hill, the late F. A. Galligan, J. Carlton Ward, Jr.

FOUR EXECUTIVE POSTS at the Glenn L. Martin Omaha plant are filled by, l. to r.: H. G. Klemm, chief engineer, C. B. Hamlin, chief inspector, L. R. Scafe, vice pres. and gen. mgr., H. M. Shealey, factory supdt., and W. O. MacArthur, comptroller.

Output total for the year to date is 12,651 and the year's total will substantially exceed the 18,000 units estimated in January as the best that could be expected.

August set engine as well as plane production records. In that month about 2,700 engines of combat sizes were turned out, of which some 700 were liquid-cooled; perhaps 500 of these were exported (exclusive of those on exported planes). About 1,200 smaller engines for trainers and tanks (which use airplane engines) were built, bringing total horsepower output to about 4,500,000. A year ago horsepower output was 1,500,000 and two years ago 500,000. By companies, Pratt & Whitney and Wright Aeronautical were running about even in August, with production of 1,700,000 hp. and 1,780,000 hp. respectively, while Allison produced some 927,000 horsepower.

Engine manufacturers, as far as floor space is concerned, have about completed their scheduled plant expansion, with better than 10,000,000 sq.ft. in operation. Further increase in production, to an estimated 12,500,000 hp. in mid-1943, will come from additional facilities in existing plants and, even more, from aircraft engine production under license by auto manufacturers, a phase which is now just beginning as Ford works into production on Pratt & Whitney engines.

Aircraft industry next year, as a result of curtailment of autos, will be second largest in the country, smaller only than steel, says Assistant Secretary of Commerce Hinckley. Between 1938 and next year labor force in the industry will have increased ten times and output nearly thirty. Tripling of labor productivity marks the shift towards mass production.

Boeing, for the past couple months, has been hiring men at about a thousand-a-week rate, has its payroll well past 20,000.

Floorspace in the industry, exclusive of facilities in auto plants, totalled 44,171,000 sq.ft. on Sept. 1—up nearly 2,000,000 ft. from the preceding month. Some 251,000 employees worked more than 58,788,000 man hours in August.

Statistics on Martin's big Navy patrol bomber, the XPB2M-1, were released for the first time when it went through its final strength tests. The 70-ton ship has a 200-ft. wing span, a 117-ft. hull length, and is powered by four Wright Duplex Cyclone 2,000-hp. engine. Forty-foot wide stabilizers carry a double tail.

Strength tests of the XPB2M cost about $100,000 and involved, at the extreme loading, flexing the wing tips six feet upward.

Martin's big ship should not be confused with the PBM-2. This is a 20-25 ton twin-engine ship, a later version of the PBM on which production was completed a couple of months ago. Large orders have been placed on the PBM-2 and deliveries should be started soon, rising gradually to a rumored one-a-day rate.

Mass production model of the Boeing Flying Fortress, the B-17E, is now being delivered. It's heavier, five feet longer, and more powerfully armed than the earlier versions. Most noticeable change is the greater stabilizer area.

Consolidated claims to have set a record, in September, by delivering in one day $1,761,000 worth of heavy bombers and flying boats. This would probably be 6-8 ships.

Netherlands Indies have ordered about 200 North American medium bombers, B-25.

Jacobs Aircraft Engine Co. is building a $13,056,327 aircraft parts plant at Pottstown.

Bendix Aviation Corp. gets an increase of $11,816,000 for additional facilities for plants at East Orange, Bendix, and Little Falls, New Jersey, Philadelphia, Rochester, and Baltimore. This is an increase of an original Defense Plant Corp. authorization of $11,500,000 for the Eclipse-Pioneer Division.

Bell Aircraft Corporation, Buffalo, is building an $8,456,175 plant at Wheatfield, N. Y.; price includes machinery and equipment for production of aircraft and parts.

Chicago Pneumatic Tool Co. takes over the Garfield, N. J. plant of the Champlain Corp., for the manufacture of hydraulic equipment used on military and naval planes.

X-Ray at NAA

Installation of an x-ray photo-template duplicating system in the Inglewood plant of North American Aviation, Inc., has been announced by J. S. Smithson, works manager. Believed superior to other template duplicating methods, the x-ray system reproduces metal templates, the lines for Masonite dies, or the profiling machines. The system will produce either positive or negative prints. Template designs are scribed on a metal sheet coated with a fluorescent lacquer. The layout is then subjected to the x-ray, which causes the fluorescent lacquer to glow. A sensitized surface placed against the master pattern and held there by a vacuum pressure arrangement, will react to the lacquer glow, but reproduce the dark lines where the lacquer has been scribed. The process is said to be foolproof with respect to accuracy and also is believed faster and cheaper than various other methods which have been used for template duplication.

North American expects this new method will speed production considerably.

In Unity Is Strength

Announcement has been made of the formation of the Universal Molded Products Corp. which has acquired the assets of Monocoupe Aeroplane and Engine Corp.; Bristol Aircraft Corp., and the entire stock of the Bristol Aircraft Products, Ltd., of Canada.

The new company, which will manufacture plastic bonded molded veneer products, has as its officers Eugene A. Hults, president; Thomas H. McKoy, Jr., chairman of the board; Charles C. Lincoln, Jr., vice pres.; Robert L. Reed, secretary.

Clare W. Bunch is vice pres. in charge of the Orlando plant, formerly Monocoupe, which will function as a separate division, as will Bristol Aircraft of Bristol, Va. Control of the corporation rests with Arthur E. Pew, Jr., and his associates of Philadelphia.

Although North American Aviation is already operating a plant at Dallas, Texas, and will soon open another at Kansas City, the engineering and management headquarters remains at the parent plant in Inglewood, Calif. To accommodate greatly expanded engineering operations resulting from the enlarged manufacturing program, a number of new buildings are being erected at the Inglewood plant. These include a new engineering building to accommodate a 100 percent increase in engineering personnel, an elaborate wind tunnel installation, and an advanced production building. Total new construction is 180,000 sq. ft., bringing the Inglewood plant area to 1,234,000 sq. ft.

The wind tunnel unit will be 75 by 171 ft. in floor area and stands 30 ft. high. An air blast of 320 m.p.h. will be driven through the tunnel by a 19-ft. five bladed propeller driven by a 1,250 hp. synchronous motor. The tunnel, of single return flow type, will have a rectangular throat 11 ft. wide and 7½ ft. high.

Machine facilities to be installed in the advance production building will represent a 150 percent gain over present equipment.

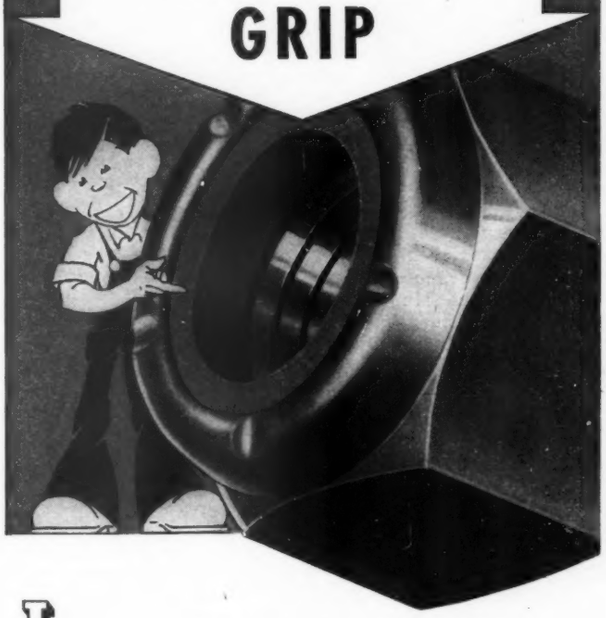
Harvill Aircraft Die Casting Corp., Inglewood, Calif., has expanded production facilities through installation of additional die casting machines, bringing the total in service to 42, turning out more than 50,000 die cast parts daily, of aluminum, magnesium and bronze alloys. Henry L. Harvill, pres., has also announced that the Harvill die casting machine, heretofore restricted to use by the Harvill company, has now been placed in production and offered for sale in a number of sizes.

Despite recent blanket wage increases granted by practically all Southern California aircraft companies, the labor picture continues to be clouded by further wage demands. At this writing the threat of a strike, authorized by employees of Consolidated Aircraft Corp., hangs over San Diego. Strike threats have also been reported from a number of smaller plants. Major problem is the continuing jurisdictional war between A.F.L. and C.I.O. which makes any final labor settlement impossible. Both union organizations continue their battle for dominance, with the defense program and aircraft management caught squarely in the middle. Lockheed and Consolidated have A.F.L. contracts while North American and Vultee are C.I.O. controlled. Other plants are similarly divided.

Menasco Manufacturing Company has reported the first profitable year in the company's history, with net earnings of $183,605 for the year ended June 30, 1941. This compares with a net loss of $190,136 in the preceding year.

Net sales for the year were $2,187,345, a 470 percent increase over the previous year's sales of $383,984.

The SELF-LOCKING AIRCRAFT NUT with a RESILIENT GRIP



IN the building of aircraft, the self-locking characteristic of Elastic Stop Nuts is vitally important. It saves valuable man-hours, reduces the possibility of human error, and eliminates the washers, pins, and wires formerly used with ordinary nuts.

Even more important however is the ability of these nuts to hold tight under the complex combinations of vibration, stress, and prolonged service encountered in flight . . . an ability inherent in the resilient grip of the non-metallic locking collar which is built into the head of each nut.

For accelerated production, and for safety, Elastic Stop Nuts have won the confidence of the aircraft industry.

Catalog contains a graphic explanation of the Elastic Stop principle, presents test and application data, illustrates uses, and lists the complete line of nuts.

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Elastic Stop SELF-LOCKING NUTS

AVIATION ABROAD

Canadian Aviation News

By James Montagnes

More than 7,000 aircraft are on order for Canada, according to an announcement made by Munitions and Supply Minister C. D. Howe late in September at Ottawa. The Dominion is now building 13 different types of aircraft, which will be cut down to six or seven, the smaller group to include one each of an elementary trainer, single engine advance trainer, twin-engine advance trainer, coastal reconnaissance amphibian, bomber and fighter. An increasing number of instruments are also being produced in Canada, and within a year the Dominion will produce, with one or two exceptions, every type of regular power plant and flight instrument. The Overhaul and Repair Division of the Munitions and Supply Department's aircraft production branch now has responsibility of 29 plants scattered from Halifax to Vancouver, handling overhaul and repairs of thousands of both training and service aircraft.

Other facts about Canada's aircraft industry came to light in a speech made about the same time by Ralph P. Bell, director-general of aircraft production. During September production of planes, from elementary trainers to Hurricane fighter and Bolingbroke bomber, was 40 weekly, as against 2 elementary trainers weekly a year ago. Of the 7,000 planes on order approximately 6,000 are to come from Canadian plants and the balance from the United States. About 30 percent have been delivered. Canada has for the time being given up the idea of manufacturing airplane engines on a large scale on assurance of the United States that Canada would get the engines it needed, thus eliminating another demand on tools needed for setting up an airplane engine industry in the Dominion. The first Canadian aluminum propeller blades have been made, and within a year Canada will export propellers to Britain. At present the aircraft industry employs nearly 35,000 as against 1,000 before the war.

Canada now makes the Handley Page Hampden medium bomber at factories of Canadian Associated Aircraft, at the rate of 15 monthly, with 63 completed of an order of 160; Stranraer flying boats at the Canadian Vickers plant at the rate of 5 per month, with 28 complete of an order of 40; Bolingbroke reconnaisance bomber at the Fairchild Aircraft plant at the rate of 15 monthly; Harvard II at the Noorduyn Aviation plant at the rate of 20 monthly which is to be speeded to 50 monthly on an order for 645; Hurricane fighter at Canadian Car & Foundry plant at 15 weekly to be speeded to 25 weekly, with 487 of an order for 1,200 completed; Tiger and Menasco Moth elementary trainer at De Havilland Aircraft plant with 777 completed; Fleet Finch and Fleet Fort at Fleet Aircraft, with 500 Finch built and production started on 200 Fort; Federal Aircraft is building Avro Anson bombers at present at one weekly to be speeded to 30 weekly on an order of 1,150. Floor space of Canadian aircraft plants before the war was 385,650 sq. ft. and before the end of 1941 will total nearly 3,000,000 sq. ft., an increase of about 780 percent.

T. W. Siers, superintendent of maintenance, Canadian Airways Ltd., was awarded Canada's major aviation trophy, the James Dalzell McKee Trans-Canada Trophy, for 1940, for "his outstanding contribution to military and civil aviation in Canada, and indirectly to British aviation, in the development of oil dilution for aircraft engines, thus solving the most difficult problem of starting aero engines under Arctic winter conditions."

The air route from the United States to Alaska via British Columbia is now ready for use, according to an announcement by J. A. Wilson, director of air services in the Department of Transport, Ottawa. Following an inspection flight of more than 2,000 miles through northern British Columbia, Alberta and the Yukon, the seven airports on the defense route were found ready for use with runways at 7,000 ft., radio range stations installed at most of the fields, and all to be equipped by year-end. The fields were built by the Department of Transport under arrangement with the Defense Department (at an estimated cost of $5,000,000), to provide an airway for United States airmen to Alaska defense outposts free from fog. They will assure that aircraft will have hops of no longer than 250 miles, while sites have been chosen for intermediate landing fields which will provide safe landing grounds every 100 miles.

On Schedule

By "Vista"

More and more emphasis is being laid upon the development of air commerce after this war is over; many of the manufacturers already have modified the specifications of the high speed bombers of today to serve as the high altitude transports of tomorrow. Such developments as the Consolidated 32 (now flying as the B-24) or the Boeing Stratoliner, already flying in this country in T.W.A.'s service as the commercial counterpart of the B-17 Flying Fortress, besides several developments under consideration and development in other plants, show that plans are already being made to continue the present boom in aviation even after the call for warplanes diminishes, and to create a worldwide air commerce.

The excellent British magazine *Flight*, in a recent issue gives one of the most complete reviews of the plans awaiting the end of the war, plans which will bring the furthermost points of the Empire to within two days' flying time, and calling for 300 to 400 m.p.h. transports flying at 30,000 feet or more. Readers will undoubtedly remember the Fairy FC-1 with pressure cabin, which was actually being built in prototype for British Overseas Airways, and the Short 14-38 which had been designed primarily for high speed transatlantic work.

The plans laid down in *Flight*, call for a route from Southampton to Auckland, via Alexandria, Karachi, Bombay, Singapore, Darwin and Sydney, a total distance of some 12,800 miles. A branch service would run from Alexandria to Durban via Kisumu and Mombasa, some 4,500 miles, or slightly over 6,600 miles from England. Their trial specification for an airplane suitable for these services at the speed given above, calls for two 3,000 hp. "H" type "unitwin" engines, a gross weight of 59,000 lb., and a disposable load of 24,500 lb., cruising at 326 m.p.h. at 28,000 feet with 50 percent power.

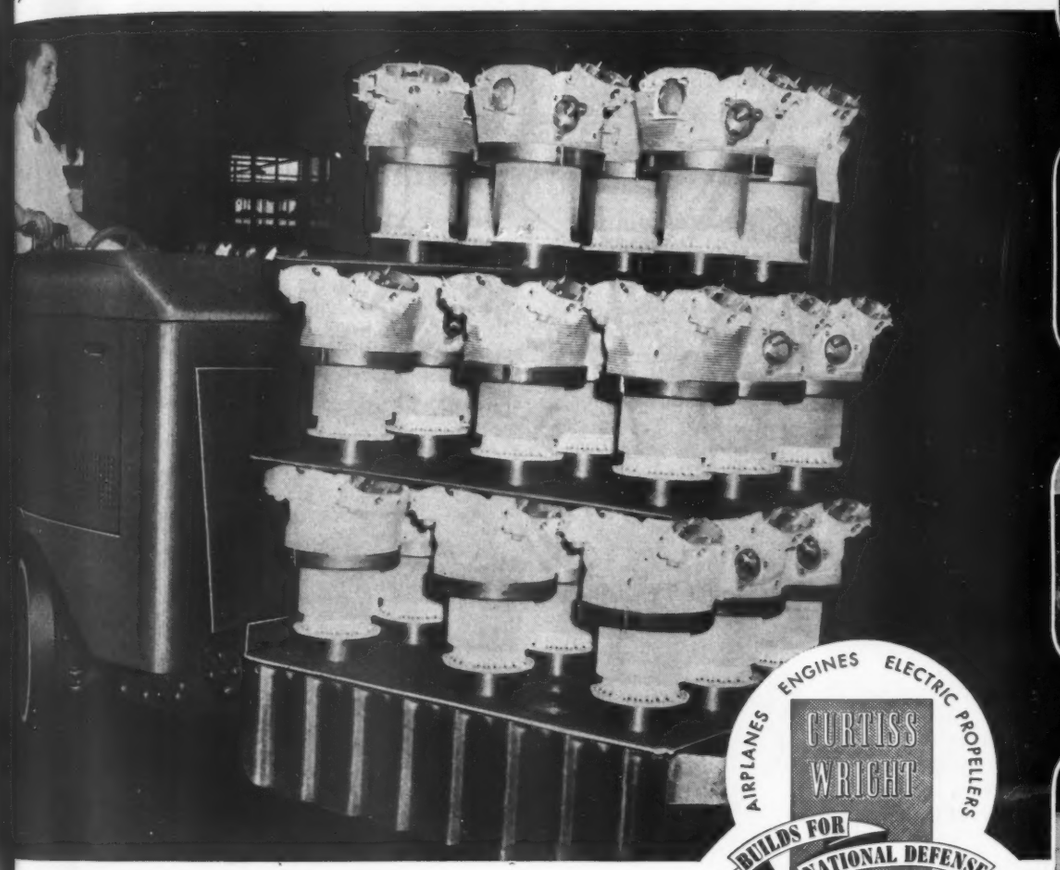
The Lockheed "Constellation", developed for Howard Hughes and Jack Frye seems to be the perfect airplane for the services proposed, besides having a greater disposable load and probably higher cruising speed. It is well known now that Pan American has formulated all its future plan on the use of 40 of these monsters—the O.P.M. has seen the value of encouraging foreign air transport business together with the domestic industry, and has recently allowed the further development and construction of a number of the Lockheed 49's (Constellations) and the Douglas DC-4, the latter more suitable for domestic uses.

Flight has developed its proposed timetables from the airplane described above, with local and express services. The local service would cover Gatwick-Sydney in 46½ hours, and Gatwick-Auckland in 52½ hours, while the Express route, making only stops at Bombay, Darwin and Auckland would cover the distance in 37¾ hours, averaging 323 m.p.h. block to block, allowing the plane 1¼ hours for stops and refueling. Similarly, the distance from England to Capetown or Durban could be covered quite easily in 30 hours' flying time.

All in all, a good map, lots of paper and some specifications of the latest commercial transports will demonstrate how this world gets smaller every day, besides bringing the unlimited possibilities of the modern airplane for world commerce forcibly to the foreground. Luckily, this country has not been standing idly by, even in the present emergency, and America's air services and equipment, be it now or after the war, will take their rightful place—in the lead!

Latest developments on the Atlantic are air express with "aircerts" on Pan American's Clippers, a big step forward in expanding the usefulness of this service, and the prediction by C. V. Whitney of P.A.A.'s board that a fifty-passenger airplane could be expected perhaps within a year, which would fly from New York to London in 7 hours.

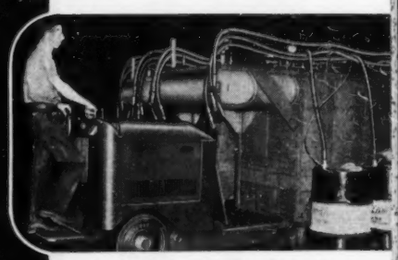
How *BAKER TRUCKS* help Curtiss-Wright "build for National Defense"



Skid-load of 24 double cylinders for Wright engines handled easily by Baker Low-Lift Truck.

AIRPLANES ENGINES ELECTRIC PROPELLERS
CURTISS WRIGHT
BUILDS FOR NATIONAL DEFENSE
Curtiss Wright

Baker Tractor pulling 4-trailer train at Buffalo Curtiss-Wright plant.



Baker truck carrying tank-loads of cutting oil for machining operations.

Baker Truck carrying crankcases for Wright engines to the assembly department at Paterson plant.

Baker Truck carrying skid-load of 4 oil drums into Paterson plant.

Baker Hy-Lift Truck unloading Allison engines in cartons weighing 2100 lbs. at Buffalo plant.

Baker Hy-Lift Truck lifting unwieldy pre-fabricated box top for shipping Curtiss fighter.

To achieve peak efficiency in its huge plants, Curtiss-Wright uses fleets of Baker Trucks for a wide variety of handling operations. A few of these are illustrated here... Mechanization of material handling is making it possible for hundreds of plants producing vital war equipment greatly to increase plant capacity without adding to floor space or man-power. Baker Trucks are thus playing a vital role in the Defense Program.

BAKER INDUSTRIAL TRUCK DIVISION
of the Baker-Raulang Company
2182 WEST 25th STREET • • CLEVELAND, OHIO

Trade mark Registered U. S. Pat. Off.
Baker INDUSTRIAL TRUCKS

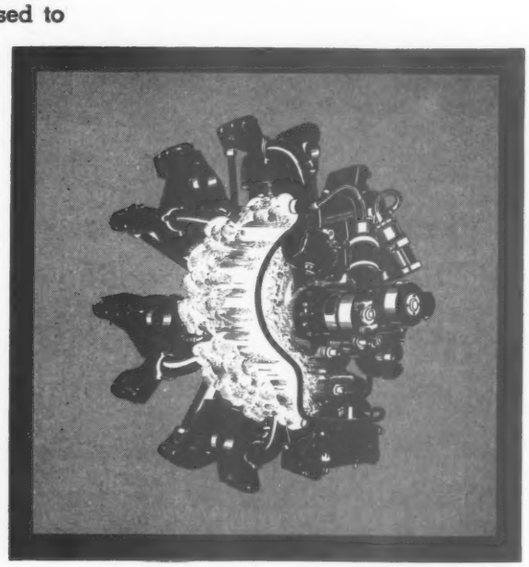
WHAT do you do about motor fires? You can't hit them with portable extinguishers. You can't ignore them.

If you're prepared, you can *kill them in 3 or 4 seconds!*

A slender metal ring holds the answer. At the touch of a control it blasts out a cloud of fire-smothering carbon dioxide snow-and-gas. Flame and fire choke to death. That's how a LUX extinguishing system snuffs out motor blazes.

Airliners and fighting planes have, for years, carried a small cylinder full of compressed LUX gas harnessed to the protective ring in engine compartments. On multi-engined planes a directional valve turns the LUX discharge into any motor which is in distress. LUX Flame Detectors give the alarm.

Do you know the full facts on LUX built-in protection against fire? Send today for your free copy of "White Magic."



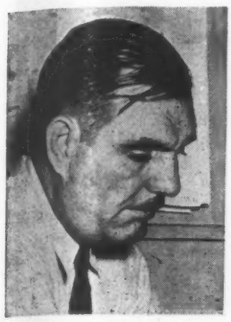
AIM...

SHOOT... KILL THE FIRE!

For cabin protection you'll want the new pistol-grip trigger-control Kidde-LUX extinguisher. Pilots like its fast one-hand action in emergencies.

LUX

Walter Kidde & Company, Inc., 1122 West Street, Bloomfield, N.J.



RICHARD S. BOUTELLE (above), assistant to the late F. A. Galligan, is named acting general manager of Fairchild Aircraft Div., Hagerstown. He had been with the Air Corps and CAA previously.

Recently nominated by the President as major general, FRANK P. LAHM has been appointed Commanding General of the Gulf Coast Air Corps Training Center. Headquarters Randolph Field, Tex.

The distinguished Daniel Guggenheim Medal for 1941 goes to JUAN T. TRIPPE, president of Pan American Airways, for the "development and successful operation of oceanic air transport."

Buckingham

CAA's Assistant Director of Pilot Training, MAJOR JOHN P. MORRIS (above), is made director following resignation of Grove Webster. W. G. Stewart takes over Major Morris' former post.

A. J. VALLEY, a former Naval pilot and for a number of years with Douglas and Lockheed, has been made hydraulics sales engineer for Adel Precision Products Corporation, Burbank, Calif.

Jon Lugh

DR. THEODORE von KARMAN, for past 12 years director of the Guggenheim Laboratory at Cal-tech, has joined Northrop Aircraft as consultant on aerodynamic and structural problems.

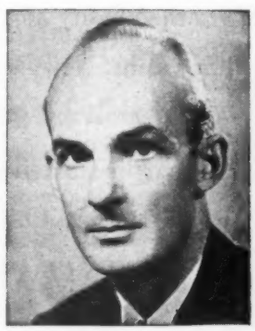
Brigadier Generals have been named to head three of the four Bomber Commands newly organized by the War Department for the Army Air Force. Chief of the Fourth Bomber Command, with headquarters at Tucson, has not yet been named. Those designated are l. to r.: BRIG. GEN. ARNOLD KROGSTAD, heading the 1st Bomber Command, 1st Air Force, with headquarters at Langley Field; BRIG. GEN. JOHN B. BROOKS, 2nd Bomber Command, 2nd Air Force, with headquarters at Fort George Wright, Spokane; BRIG. GEN. FOLLETT BRADLEY, 3rd Bomber Command, 3rd Air Force, with headquarters at Drew Field, Tampa, Fla.

Associated with Bell Aircraft since February, ROBERT L. STEVVENS (above) is appointed plant engineer, succeeding H. K. Beebe, Sr. George Carson, with the company since 1938, assists him.

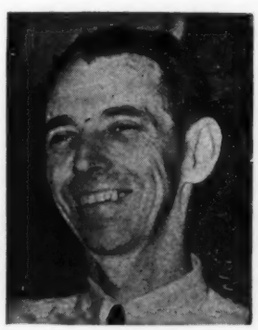
General manager of Chicago Pneumatic Tool Co.'s new aviation division is CHARLES H. DOLAN, vice pres. of Eastern Air Lines in 1933, and latterly vice pres. of Intercontinent Corp.

Said to be the only woman meteorologist in the airlines, MRS. JEAN LEWIS is employed by TWA to forecast weather by means of the new air mass analysis system. She is stationed at L. A.

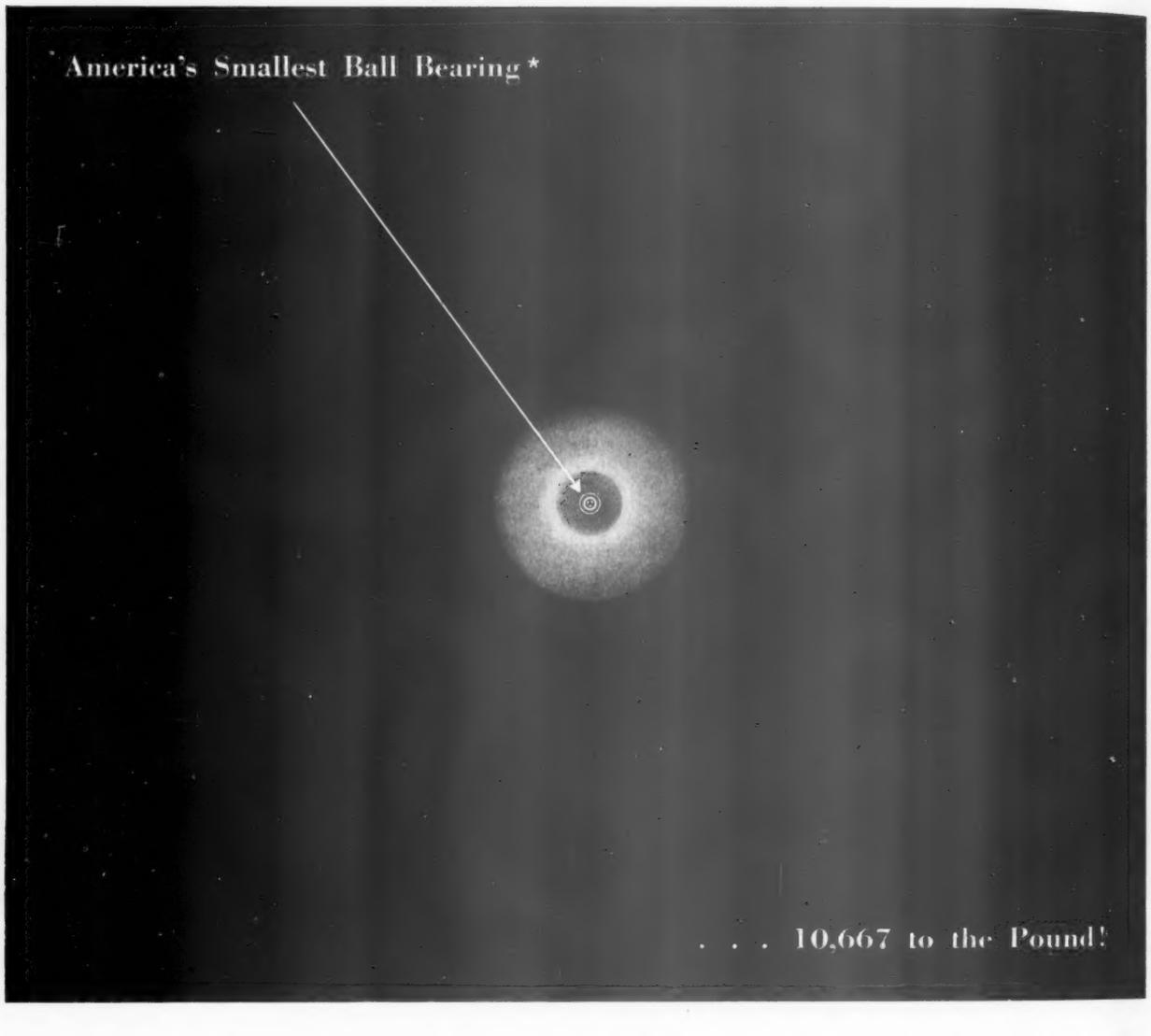
Resigning from the production staff of Lockheed, J. H. FOSTER becomes plant manager of Aircraft Components. During his 12 years with Lockheed he has held various plant management posts.



HUBERT G. LESLEY is named superintendent of airplane maintenance at Eastern Air Lines' Miami base. He joined the line in 1932, and is author of the book "Airplane Maintenance."



Obviously pleased with his promotion is ROBERT F. MEARDON, made maintenance supervisor for American Airlines at Chicago. He was formerly general foreman of line maintenance in New York.



● **Yet even New Departure, with its vast resources can hardly make them fast enough to supply the pivots of pointers on aircraft instruments. From these tiny "jewels" to the mighty 30-pound bearings for massive military units, New Departure's day-and-night effort is for Democracy's defense.**

New Departure, Division of General Motors, Bristol, Conn. Detroit, Chicago and San Francisco.

Nothing Rolls Like a Ball

*** Details**

New Departure's C-270 with three 1-millimeter balls, a separator and a race ring of only 2.7 millimeters diameter, provides the extreme sensitivity in delicate aircraft instruments without the danger of cracking from vibration which is possible with jewels.

New Departure

. . . a vital defense product

3039

Explosive Rivets

Explosive rivets made by Du Pont, several million of which are already being used in American aircraft, may prove an important factor in speeding production and simplifying design.

The rivet is provided with a high explosive secreted in a cavity at the end of the shank. Heat applied to the rivet head by an electric gun detonates the charge. The explosion expands the charged end of the shank, thus forming a "blind" head and setting the rivet.

The whole operation is performed from one side with greater ease and speed than is possible by any mechanical means now being used.

Engineers estimate that from 800 fastening points in an all metal pursuit plane to as many as 10,000 in the largest all metal bomber are accessible only from one side. That fact has presented one of the most troublesome bottlenecks in the mass production of fighting planes.

Under the best mechanical methods now used, a skilled worker can set about 2 to 4 of these "blind" fasteners a minute, after they have been placed in the holes. Equipment is comparatively costly.

The new Du Pont rivets may be installed by one workman at a rate of 15 to 20 rivets a minute, once they are in place. The riveting gun or iron weighs less than 5 lb., and the rivets themselves weigh only about a quarter as much as the usual "blind" fasteners of mechanical design.

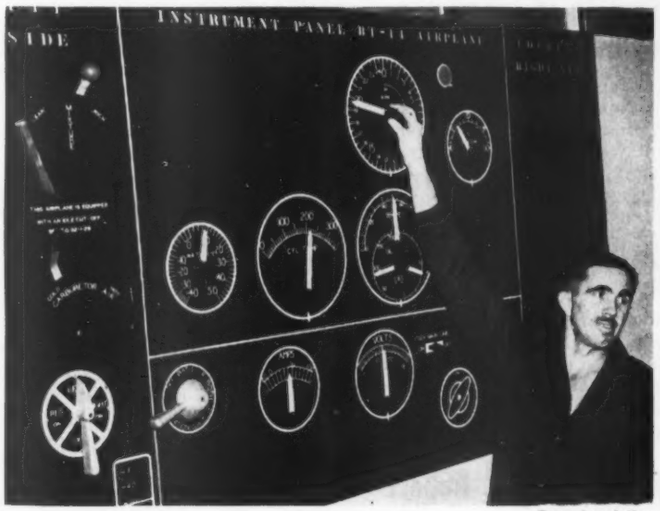
So finely has the explosive charge been controlled, that the expansion it effects may be held within limits of 20/1000th of an inch.

The all metal style of aircraft construction requires some 40,000 to 500,000 rivets or more per plane, according to the size. The job is one of the most exacting and tedious that confronts aircraft builders, and grows more so as planes become larger. The recently completed Douglas B-19 is said to have 3,000,000 rivets.

In the fall of 1940, after they had been tested and evaluated by the Army and Navy, the improved Du Pont rivets were sold in limited numbers to a few aircraft builders for further testing.

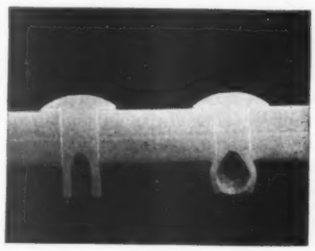
The section photograph shows the rivet in both the original and installed condition. Prior to installation, the rivet is similar to a solid rivet except for the cavity which is concentric with the shank and open at the shank end. The cavity holds the small explosive charge which when heated to a certain temperature detonates and expands the shank end uniformly without cracking. No wadding or confinement is required.

Heat necessary to installation is supplied by means of a specially designed electric tool with a silver tip, known as the Du Pont Riveting Iron. Time of installation is 1½ to 2½ seconds, from the time the riveting iron is applied until expansion takes place.



Press Association

INSTRUMENT PANELS as large as billboards are being used at Randolph Field to instruct pilots. Tech. Sgt. E. J. Baldauf twists an r.p.m. indicator on a BT-14 dial during a class session.



Explosive rivets; left, original condition, and right, installed.

The rivets now being manufactured are of aluminum alloy. They are so far made in three sizes: ⅛ in., 5/32 in. and ¼ in.; the latter two sizes just starting into limited production, and which should be available in commercial quantities in two or three months. Alloy is 17S-T.

The ⅛ in. Du Pont rivets, in four head types, modified brazier and 78 deg., 100 deg. and 115 deg. countersunk, are said to be gaining wide acceptance, particularly in the newest designs of aircraft. Each of these rivets is available in various lengths. In the case of the ⅛ in. brazier rivet, grips or total metal thicknesses of from .025 in. to .204 in. may be accommodated. In the case of the countersunk rivets, grips or total metal thicknesses from .045 in. to .204 in. may be handled. The latter permit flush riveting.

The rivets are installed in the "age hardened" condition and do not require refrigeration after heat treatment, so necessary with solid rivets in the same alloy. In shear and tension, these rivets develop values which are approximately the equivalent of driven rivets of the type now most widely used.

The Du Pont rivets are said to be safe and may be used without fear of serious injury. However, they should be handled with reasonable care. Numerous safety tests have indicated they will not detonate in mass and are quite insensitive to shock and friction. Fire and heat, however, will cause them to expand.

Cadet Invents Reflection Printing Method

One small step in the process of speeding up the rate of aircraft production, which will eliminate delay in the big airplane plants, has been developed and perfected by a flying cadet at Moffett Field, Calif. The cadet is William W. Van Dusen, a student at Cal-Tech for three years, who collaborated with his partner, Phillip Tabor, formerly assistant chief loftsman at Consolidated Aircraft Corp.

The new method, called reflection printing, will, it is said, aid greatly in subcontracting whereby one aircraft part made, say, in Detroit must fit another part made in Los Angeles. Chief advantages claimed for reflection printing are the absolute accuracy in finished reproductions, and the low cost.

New Fabric Attachment Method

A new method of attaching fabric to control surfaces of airplanes is being made available to the aircraft industry by Bell Aircraft Corp. The decision to license the new method follows after more than a year of successful results in the mass production of Airacobras.

Briefly, the Bell method of fabric attachment employs the use of a special tool which forces thin retainer strips into extrusions in the rib construction, thus holding the fabric tightly in place. Only a small amount of pressure is required, and the fabric is said to be held tightly without danger of tearing.

Benefits claimed to be gained from this method include important savings in production costs, increased speed in production, and a resulting attachment which is said to be stronger than the conventional attachment. Tests conducted by Bell Aircraft, under Air Corps supervision, clearly showed the increased strength of the attachment, it is said, as well as the fact that as additional pressure is applied, the retainer grips more tightly, without marring the fabric. No holes are made, and patches are not required over the retainer.

Time studies show a saving of approximately 75 percent over the conventional stitching procedure, and of 50 percent over the sheet metal-screw attachment systems now available.

Attaching fabric by Bell method.

PAA Speeds Preparations for African Service Extends Route from Leopoldville to Egypt

Pan American Airways recently arranged for operation of an air transport service between West Africa and the Anglo-Egyptian Sudan, inaugurated the first trans-Atlantic air express service, applied to CAB to include Suva, Fiji Islands, in its Pacific route to New Zealand, and made rapid progress setting up the new commercial and ferry service to Africa via the south Atlantic.

On the African service, PAA reports that already bases at San Juan, Port of Spain, Belem and Natal have been expanded and staffed. Across the south Atlantic, the marine air terminal on Fisherman Lake, in Liberia, is under preliminary installation, but Bathurst—the alternate port in British Gambia—is completely equipped and ready for service. So is the marine terminal at Lagoa.

Two thousand miles south, up the Congo, a Clipper base is nearing completion at Stanley Pool, the terminal for Brazzaville in French Equatorial Africa, and Leopoldville in the Belgian Congo. Preliminary installations were rapidly advancing at all West Coast ports and on the transcontinental route across Africa to Khartoum. U. S.-owned transports are already delivered to the African West Coast, presumably the DC-3s earlier turned over to the British.

Meanwhile, David S. Ingalls, former Assistant Secretary of the Navy for Air, was appointed vice-president of the new Pan American Air Ferries, Inc.

Shipments on the new air express service to Lisbon must be accompanied by "aircerts" issued by British consulates and certifying them as "non-contraband," to avoid search and seizure, while westbound shipments require certificates of origin. To simplify the problem, PAA has made public a list of non-acceptable articles such as money and patents.

Decline of refugee traffic and addition of a third weekly schedule has freed space for cargo, PAA officials explain.

Meanwhile, PAA announced that international passenger traffic clearing through Miami is expected to hit the 100,000 mark for 1941, as compared with 77,000 last year.

Record travel across the Andes was also reported by Panagra, although winter weather here has been the most severe in many years. The Trans-Andean Railway was snowed out by mid-July, leaving air transport as the only means of communication.

Sit Tight Sign

Civil Air Regulations are amended to require all scheduled air transports to provide suitable means for warning passengers to fasten their seat belts. The device must be operated by either pilot.

PCA Accident Report

CAB's report on the Penn-Central accident near Charlestown, West Virginia, April 16, 1941, in which one crew member and two passengers were seriously injured and the Boeing 247-D destroyed, states the following conclusions in part:

About five seconds after the airplane took off at Charleston, the right engine failed. Captain Wright turned to the left, flew up a narrow valley two miles. The valley ended abruptly in a ridge covered with timber. Being unable to clear the ridge, Captain Wright stalled the airplane, pancaked it into the trees.

PCA had not established adequate procedures to require its pilots to be familiar with the terrain surrounding airports, and Captain Wright was not sufficiently familiar with the terrain surrounding the Charleston Municipal Airport to deal adequately with the emergency with which he was faced.

PCA had not informed its pilots of the maximum power which could be taken under emergency conditions from Pratt & Whitney Wasp S1H1-G engines, and Captain Wright was not familiar with the amount of power which could be obtained from the engine in the emergency, and he hesitated in using it.

A tear-down inspection of the engine, together with a complete examination of the fuel system, failed to disclose any reason for the engine failure. Although two small pieces of rag were found in the carburetor grid, tests revealed that the presence of such rags in the grid would not cause any malfunctioning of the engines.

United's "Comfortizer" And Rayon Tires

After a year of tests United Air Lines has adopted rayon cord tires, which are 16 pounds per casing lighter per tire in the DC-3 size. The tires have been inspected at 100-hour intervals for cuts and irregularities. At each 650-hour overhaul, the tires were weighed, and the loss of rubber by wear was found to be 12 pounds per 1000 hours as compared with 12 pounds per 800 hours with the cotton cord type. An order for 100 of the rayon tires has been placed.

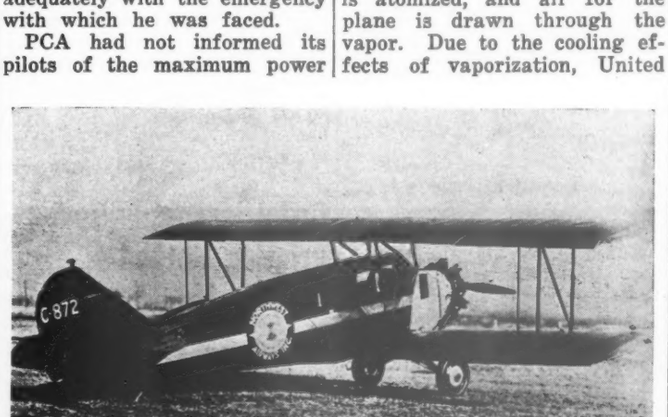
United has designed and ordered built by the O. E. Wendt Company three air conditioning units which it calls the "comfortizer." Main difference from other cooling units is that this one uses ice, water from which is atomized, and air for the plane is drawn through the vapor. Due to the cooling effects of vaporization, United says that it gets about six tons of cooling from 800 pounds of ice. For heating, the unit has a standard Delco oil burning furnace of the house-heating type. This equipment is used on the ground prior to take-off. More units will be ordered later.

Toward Safer Flying

Despite two fatal accidents early this year, domestic airlines during the first nine months of 1941 established an impressive record, having flown a total of 108,569,000 plane miles, or 54,284,500 miles per fatal accident. This compares with 39,827,570 miles per fatal accident in 1940 and 30,325,354 miles per fatal accident in 1939.

Secretary of Commerce Jesse Jones congratulated the domestic airlines on their excellent safety record established in spite of the "defense crisis" which has imposed heavy burdens both on the airlines and ground personnel responsible for operation of the airways and navigational aids. Meanwhile, Jerome Lederer, chief of the CAB Safety Bureau, and his aide in charge of accident investigation, Frank Caldwell, have been visiting airline operations personnel throughout the country to offer full assistance of CAB's facilities and counsel to help in preparations for the difficult period of winter operations.

CPT officials, to safeguard the record of safety already made in the training of 65,000 pilots, also were holding hundreds of conferences on safe flying with instructors and coordinators all over the nation who are participating in the program. Many new ideas were being developed and given wide circulation to still further improve the record of 16,194,000 miles flown per fatality.



NORTHWEST AIRLINES is now celebrating its 15th anniversary with a month of parties and dinners along its entire route. This Stinson Detroiter was the first cabin plane used by the line, in 1926. Northwest now has applications pending for routes from New York City to the Twin Cities via Canada, and from Fargo to Alaska.

TWA Talks 1200 Miles Lines Prepare UHF

Transcontinental and Western Air reports doubling the range of uninterrupted plane-to-station radio telephone communication. The Kansas City base talked, without relay, to the line's New York personnel, distant 1200 miles.

This was done under the recent licensing of TWA to use high frequencies 6510 and 10125 kc. Equipment is Bendix two-way transmitter and receiver units, which permit use of the new frequencies by mere addi-

tion of crystals. Ordinarily several relays are necessary on long distances. TWA, United, and American are reported doing similar development.

Meanwhile, TWA, UAL, AA, and AEL have completed experimentation on ultra-high frequency (140-144 megacycles), and equipment has been ordered. It is expected the new UHF will be in operation this winter.

The communications systems used by the airlines are their own property and not that of CAA.

Airlines Protect Plants

The airlines are wearing a Sherlock Holmes disguise these days, applying the microscope to any suspicious evidence of sabotage or espionage around their airplanes or airports.

While their methods vary depending on the location and layout, all the lines are alert to protect their property and aid the defense program. In many cases, professional detectives and FBI advice have been quietly sought in setting up elaborate plans for plant protection.

You'll need a badge if not a birth certificate to snoop around an airline hangar these days.

Coming Events

Oct. 30–Nov. 1 SAE National Aircraft Production Meeting (and Engineering Display), Biltmore Hotel, Los Angeles, Calif.

Oct. 31–Nov. 2 Aero Medical Association, 13th Annual Convention, Statler Hotel, Boston, Mass.

Nov. 5–6 West Coast Transportation and Maintenance Meeting, San Francisco, Calif.

Dec. 1–2 National Aviation Training Association, Annual Convention, Kansas City, Mo.

Dec. 1–5 American Society of Mechanical Engineers, Annual Meeting, Hotel Astor, New York, N. Y.

Jan. 9–11 14th Annual All American Air Maneuvers at International Airport, Miami, Florida.

Jan. 12–16 1942 SAE Annual Meeting and Engineering Display, Book Cadillac Hotel, Detroit, Mich.

April 23–25 5th Annual Southwest Aviation Conference, Hotel Muehlebach, Kansas City, Mo.

April 23–25 Women's National Aeronautical Association, Annual Convention, Hotel Phillips, Kansas City, Mo.

Air Line Doings

United Air Lines has a 14th daily Chicago-Cleveland-New York flight. Service is resumed to North Platte, Neb., and Red Bluff, Calif.; new daylight flight from Allentown-Bethlehem to the Pacific Coast. Completion of its 200,000,000th mile of flying was chalked up in September by company as a new record for airline operation. Completion of new $900,000 western maintenance base and operations headquarters at the San Francisco Municipal Airport is scheduled for early next year. In Chicago, finishing touches are being given to the exterior of the new 350,000 addition to UAL's general headquarters building, occupancy scheduled for the end of this year. Company's application to make South Bend a regular stop on the coast-to-coast airway has been recommended by the CAB examiner. Fifty operations supervisors, flight supervisors and technical personnel attended the annual operations meeting of UAL at Chicago early in September.

Braniff Airways operated its 16 flights to and from Houston on daily schedules throughout the Army Maneuvers. Ten prominent newspaper men made a flying tour of Texas as the guests of the company to witness the state's defense activities. Occasion was the inauguration of new flights from Chicago and Kansas City to Texas points, designed to link the increasing number of defense projects in Texas with the industrial Midwest and East. Pres. T. E. Braniff has lent his $10,000 Link Trainer to Texas Defense Guard. 98 per cent of Braniff Airways hostess resignations are for matrimonial reasons.

Penn-Central announces more than two-thirds of all passengers are traveling for business reasons, principally national defense. PCA in cooperation with other air lines of US conducted a survey from August 1 through August 8, to determine the extent to which the nation's air lines are being utilized for business travel. Company inaugurated on October 1, a direct route Muskegon-Chicago, equipped with PCA's 1941 Model Douglas DC-3 Capital Liners.

Trans-Canada's president says, "No air line in North America uses its equipment more intensely than the TCA." One hundred and thirty women are now employed by company to replace men who have been released for war activity. Most of the women are in the traffic department; some are engaged in mechanical work, cleaning and testing instruments.

Chicago and Southern carried 47.52 percent more revenue passengers during the first nine months of 1941 as compared with the same period of 1940. The City of Memphis dedicated company's General Office Building and General Overhaul Base there.

Canadian Colonial announced scheduled air mail, passenger, and express service to Glens Falls, N. Y.,, will continue until Nov. 30.

Pan American's request for amendment of its certificate on the San Francisco and Auckland, New Zealand route, to authorize extension to Suva, British Crown Colony of Fiji, as an intermediate stop, is assigned for October 8.

American Export Airlines' application for approval of the acquisition of all, or substantially all, of the issued and outstanding stock of TACA, S.A., was held October 2.

TACA's hearing on application for a foreign air carrier permit for persons, property, and mail between San Jose, Costa Rica, and Cristobal and/or Balboa, Canal Zone, was held October 3.

Various applications of **Canadian Colonial Airways, Eastern Air Lines, National Airlines, Pennsylvania-Central Airlines,** and **Seaboard Airways,** were consolidated for hearing by the Board on October 27.

American Airlines files application requesting a certificate authorizing air transportation of persons, property, and mail between the terminal points El Paso, and Fort Worth-Dallas, Texas, and Mexico City, Mexico, via Monterrey, Mexico; consolidated with the petition filed by the City of Laredo, Texas, requesting air transportation service; and a petition by the City of Eagle Pass, Texas requesting air service; hearings are November 17. Oral argument on fair and reasonable rate hearings were held before CAB October 15.

Inter-Island Airways, Ltd., and Ernest W. Green, et al., asked for approval of certain interlocking relationships on October 3.

HOW FAR CAN HE JUMP?

You can't tell how far a frog can jump by looking at him, and you can't tell how good a tracing cloth is by reading advertisements or by listening to a salestalk.

In the case of the frog, you give him a poke to make him jump — and you find out how good a jumper he is. In the case of tracing cloth, you put it to work in the drafting room — and in actual use, you find out how well it performs. That is the only evidence you can believe—and we ask you to make that test, because we know what you will find out. Of course, we think you will buy our product and that will be to our profit — but further than that, we think you will profit also. The test won't cost you one cent — just ask your dealer or write to us for free working samples of Micro-Weave.

The Holliston Mills, Inc.
NORWOOD, MASS.
BOSTON NEW YORK PHILADELPHIA
CHICAGO ST. LOUIS RICHMOND

LOCKHEED'S "LIGHTNING" P-38 —Lockheed fuels this sensational pursuit-interceptor and all other Lockheed ships with Shell Aviation Gasoline and lubricates them with AeroShell Oil.

ON SHELL AVIATION GASOLINE AND AEROSHELL OIL

LIKE a bolt from the blue, Lockheed's P-38 rides the sky . . . winged lightning on the loose. Only 100 octane aviation gasoline (produced commercially for the first time by Shell) can make such speed possible. And only an oil that can stand the gaff can endure such a punishing pace.

Small wonder, then, that Lockheed fuels the "Lightning's" two 1150 H.P. engines with Shell 100 octane gasoline . . . lubricates them with AeroShell Oil —the lubricant that reduces engine wear, stands up under sustained high speeds, gives instant lubrication, helps keep rings running free. Those are the reasons so many leading aircraft and engine manufacturers have approved AeroShell Oil.

Find out today why it will pay *you* to stock fast-selling Shell Aviation Products. Address: Shell Oil Company, Incorporated, 50 West 50th St., New York, or 100 Bush St., San Francisco, Cal.

SHELL

AVIATION PRODUCTS

Vultee Aircraft expects to turn a net loss of $593,000 at the end of its first six months into a sizeable profit for the fiscal year ending November 30, 1941, due in large part to the excellent results obtained from its powered mechanized assembly line. Since this mechanized line came in full operation last May there has been a 22 percent reduction in production costs and employment has been stabilized around 6,600 despite an ever increasing production volume. Shipments for the fiscal year may be in the neighborhood of $36,000,000. For the nine months ended August 31 they had jumped to around $18,000,000, as compared with $3,000,000 in the similar 1940 period.

Solar Aircraft's backlog has been boosted by several large orders including one for over $2,000,000 of exhaust manifolds, and totaled $11,285,000 at last reports. Part of this large backlog has been subcontracted to the company's affiliate, Edward G. Budd Mfg. Co. of Philadelphia for eastern manufacture, according to Edmund T. Price, president. Operations for the four months ended August 31, 1941 resulted in shipments at a new peak of $1,346,000.

Recent aircraft financing includes a public offering of Aeronca Aircraft preferred stock and common stock warrants by a New York underwriting group. The senior stock (30,000 shares) was priced at $15 a share and the warrants (20,000) at 10 cents per warrant. Net proceeds, estimated at $368,000, will be used to finance larger inventories, enlarge the plant and for other corporate purposes.

A breakdown of General Motors' part in the aircraft defense program shows that in early part of September the Allison engine division had $233,200,000 in contracts for liquid-cooled engines, while Chevrolet and Buick held combined orders amounting to $218,400,000 for Pratt & Whitney type air-cooled engines. In other divisions General Motors has contracts for $70,000,000 in propellers, $66,000,000 for parts and subassemblies for North American bombers and $38,100,000 for miscellaneous aircraft equipment.

Piper Aircraft has been turning out Cubs at the rate of 300 a month recently. Production for the fiscal year ended September 30 totaled around 3,600 planes and for the calendar year the output will be somewhat larger. Net earnings for the first nine months were approximately $250,000, before taxes. The company has priority ratings for the sale of its planes to nine different types of operators, including civilian pilot training, pipe line control, etc. Training schools may sell them to civilians, as they can other civilian planes, after they have had 300 hours of training work.

By Raymond Hoadley

November might well be known as the "stockholders month" in aviation for this is the month when the majority of aircraft companies cut the melon and give their shareholders tangible evidence of the year's efforts through a dividend payment. More aircraft concerns are in the dividend paying ranks today than ever before and their disbursements will average much larger than in 1940. Only about six years ago there were less than six regular dividend paying concerns in the whole aviation group; now there are a score or more. Despite higher taxes and lower profit margins, the increased volume in 1941 will push aggregate earnings of the industry through to new record levels. The airlines, on the other hand, lagged sadly behind, earningswise, in the first half of the year but turned losses into profits in the big volume summer months and continued to show more satisfactory earning power in the early fall months.

Industry Backlog

Defense orders of the aircraft manufacturers now total approximately $8,000,000,000, as compared with $3,144,000,000 a year ago. Unfilled orders for military planes, engines and propellers have nearly doubled in the last six months, reflecting in considerable part the initial orders to Boeing, Consolidated, Douglas, Ford and Vega for four-engine ships in the new heavy bomber program. Backlog of the Curtiss-Wright Corp., makers of several type planes, engines and propellers, now hovers around the one-billion dollar mark, thus ranking this company among the first three or four American industrial companies with respect to volume of defense contracts. In fact, Curtiss-Wright's unfilled orders exceed those reported by the entire industry in the spring of 1939.

National defense plans call for the automotive industry to undertake nearly one-third of the airplane production program through the manufacture of parts, sub-assemblies, engines and propellers. The Ford Motor Company is the only one of the seven larger motor concerns now engaged in aircraft work that will assemble complete planes.

Aircraft production now runs better than 2,000 tactical and training planes a month. Output is about evenly divided between these two categories but when peak production is reached it is expected that two tactical units will be turned out for every trainer produced. Present indications are that this peak—50,000 military planes a year—will be achieved before the end of 1942.

Large scale aid to Russia is a new development which may easily result in further expansion of the production program now scheduled, especially if it is determined to superimpose Soviet needs on the requirements of the British Empire, Dutch East Indies, China and our own defense.

The following table gives the latest approximate backlogs of the defense aircraft producers:

Aviation Corp.	$15,000,000
Beech	88,000,000
Bell	145,000,000
Boeing	628,000,000
Brewster	93,500,000
Cessna	29,000,000
Consolidated	734,000,000
Continental Motors	28,000,000
Curtiss-Wright	975,000,000
Douglas	619,000,000
Fairchild	24,000,000
Ford	737,000,000
General Motors	595,000,000
Grumman	68,500,000
Jacobs	20,000,000
Lockheed	275,000,000
Martin	635,000,000
Nash	45,000,000
North American	380,000,000
Northrop	90,000,000
Packard	167,000,000
Republic	66,000,000
Ryan	14,000,000
Studebaker	100,000,000
United Aircraft	410,500,000
Vega	260,000,000
Vultee	184,000,000
All others (vendors)	530,000,000
	$7,945,500,000

Taylorcraft, Piper and Aeronca may be added to our industry backlog table in the near future for each of these companies recently received initial orders from the Army Air Corps for a small number of planes. The Army rented a goodly number of these units (grasshoppers, Army men call them) during the southern maneuvers and trade officials are encouraged to believe that the favorable comment they received may lead to substantial defense orders in the near future.

The domestic airlines as a group came out of the red in July after reporting a collective net loss of around $450,000 for the first six months of 1941 as compared with net income in excess of $2,000,000 in the similar 1940 period. As a result of the record breaking July operations, the airlines were nearly $1,000,000 in the black on August 1. As traffic of some of the lines was heavier in August and September than in July, earnings for the year may not show the decline from 1940 that had been expected.

Consolidated Aircraft started Wall Street thinking in terms of dividends on aviation stocks this fall by declaring a $2 cash dividend the same day a 100 percent stock dividend was announced. Stockholders recently approved an increase in the authorized common stock from 1,200,000 to 2,400,000 shares. Company officials said they saw no necessity for issuance of additional stock at this time except that required for the stock dividend. Other old line companies that are expected to consider year-end dividend payments include *Curtiss-Wright, Douglas and United Aircraft.* Also mentmentioned in the financial district are *Lockheed, Martin, Grumman and Sperry.* Now that the year's operations are approaching a close, the companies can estimate fairly accurately what 1941 profits will be and decide accordingly on the percentage, if any, to be disbursed to shareholders.

Air Associates plans the issuance of 50,000 shares of $1.37½ cumulative convertible preferred stock and a maximum of 100,000 shares of common stock. The junior stock would be reserved for issuance on conversion of the preferred stock. About $300,000 of the proceeds from the offering will be used to repay promissory notes and

$200,000 for purchase of additional machinery. The balance would be used for working capital.

Adel Precision Products Corp. of Los Angeles has registered with the SEC an offering of 120,000 shares of capital stock to be sold at $3 a share. Net proceeds of about $340,000 from the sale will be used to retire debt and for working capital.

National Aviation Corp., after long negotiations has sold the Washington-Hoover Airport to the federal government, according to Frank F. Russell, president of the aviation investment company. The transaction involved the payment of $1,000,000 in cash. Assets of the company are now largely represented by a portfolio of marketable securities and cash.

The receivers of Seaboard Air Line Railway have recommended to the federal court that the banking firm of Ladenburg Thalmann of New York be granted the authority to finance the railroad's subsidiary, Seaboard Airways, Inc. The bankers would supply funds to prosecute to a conclusion the airline's route certificate applications pending before the CAB. If the court grants the petition it will mean that the railroad would lose control of the airline.

Kellett Autogiro Corp. third quarter sales totaled $484,015, as against $135,677 during the same period a year ago. Unfilled orders on Sept. 30 were $3,092,603, as compared with $1,857,357 at the start of the year, according to R. G. Kellett, vice-president of the Philadelphia company.

Lockheed Aircraft's president, Robert E. Gross, in an interim report to shareholders revealed that sales for the first six months this year exceeded by 25 percent those for the entire year 1940. Earnings for the period amounted to $3,833,306 or $3.83 a share, as compared with $2,022,619 or $2.02 a share in the same 1940 months.

Aviation Corp. reported earnings of $1,459,649 or 25 cents a share in the nine months ended Aug. 31, compared with $72,855 or two cents a share the previous nine months. The Company has been granted exemption by the SEC from regulation under the Investment Company Act of 1940 because it is primarily engaged in the manufacture and sale of aircraft, engines, propellers, parts and the construction of naval vessels.

Material Shortages

The new super-defense board SPAB is plugging hard to get new defense metal capacity built and into operation as soon as possible, especially the two metals of greatest concern to the aircraft industry—aluminum and magnesium. One of their greatest difficulties has been to convince Federal Loan Administrator Jesse Jones that all customary red tape should be cut to speed financing plans for the new facilities. Now, however, Mr. Jones has closed negotiations for an additional 660,000,000 pounds of aluminum which will give the government the overall capacity of 1½ billion pounds it has been shooting for. This production probably can be obtained in from twelve to fifteen months.

Meanwhile the shortage in aluminum scrap continues. The much-heralded aluminum scrap drive last summer yielded only 1,835,139 pounds of scrap, a total equivalent to the amount of virgin aluminum needed in 1,000 fighter planes or 350 four-motored bombers. Defense experts had hoped for a minimum to 7,000,000 pounds.

As respects magnesium, the scarcest of all metals, OPM officials say that the "tremendously" increased needs for aircraft and bombs for the British require an increase in this lightest of all metals from the present 30,000,000 pounds to 400,000,000 pounds a year. Previously it had been felt that a 75,000,000 pound expansion would do. Dow Chemical Company is building new plants which will vastly expand its magnesium capacity and the federal loan administrator was completing arrangements for the rest of the expansion program with several other companies when this was written.

Here and There . . . Starting from scratch two years ago Northrop Aircraft is in thirteenth place among aircraft concerns in both sales and plant area . . . Chicago & Southern Air Lines reports a loss of $111,931 for the year ended June 30, 1941, compared with a profit of $29,668 the preceding year . . . Present output of Jacobs Aircraft Engine Co. is estimated at around $1,500,000 monthly . . . Republic Aircraft deliveries in July and August were the highest in any two month period in the company's history . . . Beech Aircraft shipments in Sept. were $1,886,000 . . . TWA has been awarded a government order to train four-engine aircraft crews for service with Air Corps ferry command. Cost of the instruction is not to exceed $599,760. Vultee's deliveries may reach $36,000,000 in the fiscal year to Nov. 30 . . . Liberty Aircraft Products has exercised its option to purchase 100,000 shares of Autocar Co. common from Phoenix Securities.

Recent Awards

War Department

Weston Electrical Inst. Corp., Newark, N. J., $1,678,356 for instruments.

Standard Aircraft Products, Inc., Dayton, Ohio, $586,380 for thermostat assemblies.

Ford Motor Co., Dearborn, Mich., $231,742,500 for airplanes and parts.

Bendix Aviation Corp., South Bend, Ind., $224,596 for carburetor assemblies and parts.

North American Aviation, Inc., Inglewood, Calif., $153,450 for cells and parts for gun compartments.

Wright Aeronautical Corp., Paterson, N. J., $284,509 for generator assemblies.

Charles Engelhard, Inc., Newark, N. J., $360,036 for indicator assemblies.

Electric Storage Battery Co., Philadelphia, Penna., $475,020 for storage batteries.

Bendix Aviation Corp., South Bend, Ind., $147,840 for motor, valve and charger assys.

Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $152,400 for aircraft equipment.

General Electric Co., Schenectady, N. Y., $228,000 for instruments.

Lawson Mfg. Co., Pittsburgh, Penna., $150,056 for stand assemblies.

Talbert Abrams Co., Lansing, Mich., $190,684 for printer assemblies.

Bendix Aviation Corp., South Bend, Indiana, $130,765 for maintenance parts.

Vultee Aircraft, Inc., Downey, Calif., $490,000 for gas tanks.

Electric Auto Lite Co., LaCrosse, Wisc., $356,735 for gauges.

Douglas Aircraft Co., Inc., Santa Monica, Calif., $155,532 for cowlings.

Elgin National Watch Co., Elgin, Illinois, $160,667 for clocks.

Fairchild Engine & Airplane Corp., Long Island, N. Y., $207,988 for engine parts.

Bendix Aviation Corp., South Bend, Ind., $224,596 for carburetor assemblies.

Service Tool & Eng. Co., Dayton, Ohio, $383,520 for sight assemblies.

Douglas Aircraft Co., Inc., Santa Monica, $6,061,385 for airplanes and parts.

Lewis Engineering Co., Naugatuck, Conn., $538,488 for thermometer indicators.

General Motors Corp., Anderson, Indiana, $1,496,073 for generator assemblies.

General Motors Corp., Indianapolis, Ind., $8,197,051 for engine parts.

Folmer Graflex Corp., Rochester, N. Y., $4,297,752 for aircraft cameras.

Bell Aircraft Corp., Buffalo, N. Y., $522,632 for gun mount adapters.

Leece-Neville Co., Cleveland, Ohio, $1,704,250 for generator and panel assemblies.

Consolidated Aircraft Corp., San Diego, Calif., $4,003,940 for engine parts.

Westinghouse Electrical & Mfg. Co., Dayton, Ohio, $685,000 for generator assemblies.

Vultee Aircraft, Inc., Downey, Calif., $1,044,400 for airframe spares.

Boeing Aircraft Co., Seattle Washington, $172,267 for maintenance parts.

Air Associates, Inc., Bendix, N. J., $144,047 for nuts.

Oneida, Ltd., Oneida, N. Y., $114,000 for bomb shackle assys.

Pump Engineering Service Corp., Cleveland, Ohio, 161,450 for vacuum pump assemblies.

Glenn L. Martin Co., Baltimore, Md., $136,040 for tanks and fuel gauges.

Northrop Aircraft, Inc., Hawthorne, Calif., $18,411,812 for airplanes & parts.

Fairchild Engine & Airplane Corp., Farmingdale, N. Y., $2,494,964 for engines & parts.

Curtiss-Wright Corp., Caldwell, N. J., $156,032 for propeller assemblies.

Glenn L. Martin Co., Baltimore, Md., $123,071 for gun turrets.

Cambridge Instrument Co., New York City, $110,200 for mixture indicators.

Ainsworth Mfg. Corp., Detroit, Mich., $197,673 for bomb shackle assemblies.

Okonite Co., Chicago, Ill., $115,045 for cable.

Brewster Aeronautical Corp., Long Island, N. Y., $163,136 for gas tanks.

Hickok Electrical Instrument Co., Cleveland, Ohio, $658,590 for thermometer indicators.

General Motors Corp., Indianapolis, Ind., $8,501,605 for engines and parts.

Boeing Aircraft Co., Seattle, Washington, $336,447,057 for airplanes and parts.

Douglas Aircraft Co., Inc., Santa Monica, Calif., $9,709,616 for planes and parts.

Bundell Machine & Tool Co., Cleveland, Ohio, $104,154 for propeller & crank shaft parts.

Cambridge Instrument Co., Inc., New York City, $359,879 for fuel mixture assemblies.

General Motors Corp., Indianapolis, Ind., $119,965 for parts for engines.

Square D Co., Elmhurst, N. Y., $330,000 for compasses.

Leece-Neville Co., Cleveland, Ohio, $313,091 for maintenance parts.

Longines Wittnauer Watch Co., New York City, $131,681 for clock assemblies.

Bendix Aviation Corp., South Bend, Ind., $466,168 for carburetors and parts.

Air Associates, Inc., Bendix, N. J., $145,125 for aircraft mooring kits.

General Bronze Corp., Long Island, N. Y., $269,100 for dolly assemblies, propellers.

Navy Department

None.

Propose Air Mileage For Government Workers

Government employes traveling on official business in their own airplanes would be compensated on the same basis now allowed for field work in private automobiles under a bill introduced in Congress by Senator Lister Hill (D., Ala.).

Since it does not call for additional appropriations, there is a fair chance that the measure will be approved. If so, private flyers in the federal service will have a fine opportunity to increase their flying time while saving working time for Uncle Sam.

With sales now running higher than $500,000 a month, Adel Precision Products Corp., Burbank, Calif., accessory manufacturer, has arranged additional private financing to provide $500,000 for working capital purposes. It is believed the company will issue 150,000 additional shares of its authorized 500,000 shares of capital stock.

Synthane's

Partnership of Properties valuable in Republic Lancer production

The fast YP-43 Lancer, built by Republic Aviation Corporation for the U. S. Army Air Corps.

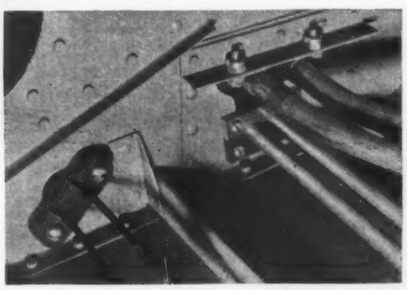
MANY small parts for the Republic Lancer are made from Synthane Bakelite-laminated.

The light weight of Synthane (Density approx. .05 lbs. per cu. in.) is, of course, highly desirable. But what makes Synthane valuable to Republic and other manufacturers is light weight plus a partnership of properties—structural strength, dielectric strength, corrosion resistance, and many others. Important and imperative now is the ease of machining Synthane accurately from sheets, rods and tubes.

SYNTHANE CORPORATION, OAKS, PENNA.

Synthane is easy to machine. Operator bandsawing a sheet of Synthane at the Republic plant, Farmingdale, L. I.

Fair leads and tube clamps on the Lancer, machined from Synthane. Synthane guides cables, grips tubes without chafing.



Highly dielectric, Synthane is used here in the Republic "Lancer"—and in many other makes of planes—for terminal and connection blocks.

THE AVIATION INDUSTRY *OK's* SYNTHANE

Bakelite-laminated for

LIGHT WEIGHT with Structural Strength
LIGHT WEIGHT with Corrosion Resistance
LIGHT WEIGHT with High Dielectric Strength
LIGHT WEIGHT with Ease of Machining

SYNTHANE

SHEETS • RODS • TUBES • FABRICATED PARTS • SILENT STABILIZED GEAR MATERIAL

SYNTHANE TECHNICAL PLASTICS

Materials to remember, specify and use for aircraft parts

Go With Schatz for Progress
APPROVED BY AIRCRAFT ENGINEERS • USED IN CONSTANTLY INCREASING QUANTITIES BY LEADING AIRCRAFT AND PULLEY MANUFACTURERS • SUCCESSFULLY MEET ALL SPECIFICATIONS • PRECISE PERFORMANCE, SAFETY AND DEPENDABLE CONTROL UNDER ALL FLYING CONDITIONS.
SCHATZ
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AIRCRAFT
BALL BEARINGS
THE SCHATZ MANUFACTURING CO.
POUGHKEEPSIE, N. Y.
Detroit Office: 2640 Book Tower • Chicago Office: 902 S. Wabash Ave.
Cleveland Office: 402 Swetland Building • Los Angeles Office: 5410 Wilshire Blvd.

U.S. Hits Axis In South America

Speaking on Pan American Aviation Day at Elkins, W. Va., Grant Mason, CAB member, reported important gains in combating Axis airline penetration in South America. In this connection, he outlined a program to train 500 Latin American pilots and technicians in the United States.

He said that British cruisers 100 miles off the coast of Brazil had sighted a Sindicator Condor's four-engine transport. Argentine officials conducted an investigation resulting in the promulgation of a regulation forbidding any of Condor's planes from making any but scheduled flights without an Argentine Army officer aboard.

LATI, the Italian transatlantic carrier, made a similar seven-hour unauthorized flight to sea from Natal, for which they were fined by the Brazilian Government. LATI is a vital link in Axis communications between home governments and representatives throughout the western hemisphere.

A major objective of the present drive to expand locally-owned and American lines in Latin America is the complete elimination of the Axis from the air. LATI has been added to the U. S. "blacklist" of Axis firms in South America.

J. S. PARKER, JR., named Technical Assistant to Administrator Connolly of CAA to coordinate plans for training 500 pilots and technicians from Latin-American Republics under sponsorship of U. S. Government. CAA and Army will train 275 pilots and CAA will train 120 service mechanics, 87 instructor mechanics and 18 aeronautical administrative engineers from below the Rio Grande. Parker also is chief of the CPT Ground School Section.

Bangalore's Aircraft Factory Ready. The first of a possible network of high-speed modern aircraft plants in India was ready to start operations at Bangalore under the leadership of William Pawley, well-known American aviation expert, it was announced last month. Construction and plans for this plant, known as the Indian Aircraft Co. Ltd. were reported on these pages in April 1941; production will be on a 24 hour basis, concentrating on fighters and bombers, though it is hoped that after the present conflict commercial and sports aircraft will be built for the Indian market.

Press Association

THIS NEW HAWKER HURRICANE II has four 20 mm. cannon. Another version of this fighter has 12 machine guns, all in the wings.

Names for Planes

Corsair, Buccaneer, Seagull, Coronado . . . It isn't Pullman cars, it's Navy warplanes. Secretary Knox has decided that Navy's letter-and-number designations for its aircraft are too prosaic for the public; from now on they are to have warlike names. There's no apparent system used in applying the names; some of them are picked up from the British; some just sound good.

Fighter names: Brewster F2A is Buffalo, Grumman F4F (which used to be known as the Skyrocket) is the Wildcat, Vought F4U is the Corsair.

Observation: Curtiss SO3C is the Seagull while Navy OS2N and Vought OS2U share the name Kingfisher.

Dive bombers: Brewster SB-2A is Buccaneer, Curtiss SB2C is Helldiver, Douglas SBD is Dauntless, and Vought SB2U is the Vindicator.

Torpedo bombers: Douglas TBD is Devastator and Grumman TBF is the Avenger.

Patrol bombers: Boeing PBB is the Sea Ranger, Martin PBM is Mariner, Consolidated PBY is Catalina and PB2Y Coronado.

But the numbers, somehow, keep creeping back. Already we have Wildcat IV and Mariner II.

Mechanic Training Proposed for CPTP

Expansion of the CPTP program to allow the training of aircraft mechanics as well as pilots is proposed in a bill recently introduced in Congress by Rep. Jennings Randolph and Senator Pat McCarran at the request of the National Aviation Training Association, a group of civilian schools, mostly CPT contractors.

There is considerable doubt that the suggestion will be adopted, however, in view of the existing programs now under the Office of Education which has some $100,000,000 for defense training. This fund, however, can flow only into public schools and cannot be used, as in the case of CPTP, for contracts with private schools.

The Casey Jones committee of the Aeronautical Chamber of Commerce is more inclined to favor concentration of training in the present agencies rather than creation of a new program.

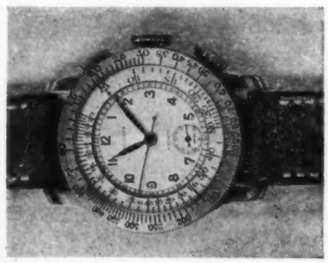
Four PAA officials reached Cairo, Egypt, in mid-October to discuss plans for using airline pilots to ferry American-built planes to the Sudan, over PAA's new inland African route, thus relieving British pilots for other duty. Another reason is that British pilots, less experienced, and flying unfamiliar planes, are cracking up too many of them, reportedly about 20 percent.

Republic Aviation's new plant at Farmingdale, L. I., is nearing completion, is already rolling P-43s from three production lines. Ralph Damon, president, says plant will be tooled for production of the P-47 "Thunderbolt," first Army pursuit plane to take a 2000 h.p. engine —Pratt & Whitney Double Row Wasp.

Revenue passenger miles flown by the airlines, first 8 months 1941, increased 30.46% over same period last year—from 666,517,142 to 869,518,236. In July, air express shipments passed 1,000,000 pounds for first time.

Aircooled Housewarming

The officers and directors of Aircooled Motors have decided to throw a homewarming to mark the opening of the new engineering building and experimental laboratory. Formal invitations will be sent to a select list of top men in the aircraft industry and to a group of city, state and federal officials, to attend the event which takes place at 3 p.m. Saturday Nov. 8, at the plant on Liverpool Rd., Syracuse, N. Y.



Gardner Watch

A unique flight calculator watch which tells time, time out, speed and distance, has been made by Longines-Wittnauer Watch Co. for Lester D. Gardner, vice pres. of Institute of Aeronautical Sciences and former Editor of AVIATION. The design for the calculating features of the watch was made by Maj. Gardner.

Around the center dial are two rotatable rings, inner of which is rotated by separate winding stem and the outer by hand. To calculate elapsed time, arrow "M" on inner ring is set opposite minute hand, and arrow "H" on outer ring opposite hour hand, at beginning of flight. From these "fixes" elapsed time of a flight is easily calculated.

OPERATORS CORNER

L. A. Airport Survey

An intensive study of the Los Angeles County airport and air traffic problem is being made by the Aviation Committee of Los Angeles Chamber of Commerce, with the collaboration of the CAA and the Army Air Corps. Intensification of transport flying, factory test flying, and military and CPTP training have all combined to bring the world's greatest concentration of flying activity to Los Angeles. There are more than 20 airports active in the Los Angeles city neighborhood. Yet a preliminary military survey indicates that the Los Angeles area is short some 30 airports of the minimum which would be required for adequate military air operations in defense of the area.

Glen B. Eastburn, manager of the Aviation Department of the Los Angeles Chamber of Commerce, is heading up the airport study. He recently got a birds-eye view of the problem by making a one-day flight to 20 airports in the Los Angeles area, flying in an Interstate Cadet piloted by our Pacific Coast Editor, Charles F. McReynolds.

Jamestown Rendezvous

That light planes are a definite asset to national defense was emphasized by speakers at a rendezvous of pilots who flew their craft to the Municipal Airport at Jamestown, N. Y., September 7th. More than 200 fliers were registered and attended a breakfast given by Neil McCray, lessee of the airport. Others landed at intervals during the day.

Mr. McCray explained that the purpose of the rendezvous was to interest pilots of light planes in the formation of a civilian air corps reserve to work behind the lines in case of a national emergency. He declared the way in which the pilots assembled at the Jamestown airport for just a friendly meeting under peacetime conditions illustrated the co-operation which could be expected under a government order for the mobilization of such planes.

Indication for forthcoming government regulations of light planes was given by Floyd Johnson of Detroit, sales manager of the Stinson Aircraft Corporation, who said that within six months an order will be issued for the organization of the "home guards."

Interstate Aircraft Photo

L. A. AIRPORT SURVEY GROUP: l to r: Don P. Smith, Interstate President; Glen B. Eastburn, aviation mgr., L. A. Chamber of Commerce; Woodruff DeSilva, Mgr. L. A. Municipal Airport; C. F. McReynolds, Aviation's Pacific Coast Editor, who flew the ship.

William T. Piper, head of the Piper Aircraft Corporation, declared the rendezvous one of the largest gatherings of light planes. "This shows where the interest actually is," he remarked. "Most people think flying is a rich man's game. Flying will eventually be the cheapest mode of transportation. Here, today, we have stirred up enthusiasm for private flying. We should get an organization formed to be of service to our government."

N.A.T.A. Convention

The Second Annual Convention of the National Aviation Training Association will be held in Kansas City on December 1 and 2. The first convention brought several hundred operators to Kansas City and even more are expected this year.

Spartan Trains Women

Last month the Spartan School of Aeronautics at Tulsa, Okla., inaugurated a three months instrument technicians course for women. The course takes eight hours a day for three months and includes laboratory practice, disassembly, overhaul, reassembly, and calibration of all standard flight instruments. Tuition is $225. Considerable new equipment has been installed for this course.

Spartan recently brought its total floor space up to 342,000 when it moved Army mechanics students into a new 548 by 100 ft. buildinig. The new building houses eight class rooms and a large shop.

Rankin Academy

Construction work on the recently announced expansion program of two new hangars, four barracks and four runways for the Rankin Aeronautical Academy here is under way, according to announcement by J. G. "Tex" Rankin, president of the academy.

Estimated cost of the new buildings and runways is $300,000. This figure, plus the cost of the original buildings, represents an investment of $650,000 in the academy, which is one of the newest of the U.S. Army Air Corps Training schools for Aviation Cadets.

Each of the new hangars will be 100 x 200 feet. The hangars will increase the aircraft storage capacity of the school from 36 to 108 planes.

The new barracks, which will raise the student capacity of the school from 125 to 400, are air-conditioned and will offer other improvements in living quarters and study rooms for the cadets.

Each of the four runways to be constructed will be 3000 ft. long and 100 ft. wide, permitting landings from any direction.

Need Link Trainer Operators

CAA needs more Link Trainer Operators, according to a recent Civil Service announcement. Operators receive $2,900 a year and instructors receive $3,200. See your Post Office for details.

California Flyers School of Aeronautics at Los Angeles Airport is putting in a new athletic program for its Air Corps Cadets. Under the direction of Leo T. Johnson, Civilian Director of Physical Training in that area, a new athletic field has been completed and both cadets and civilian students will get a regular program of sports each day.

The Robertson Aircraft Corporation at Robertson, Mo., recently was approved by CAA as a mechanics school to give courses leading to Aircraft and Engine Certificates. The school has been in operation for 22 years, in conjunction with an Approved Advanced Flying School. Major Wm. B. Robertson is president of the corporation.

The California desert is no longer barren. Shoving the cactus and Joshua trees aside, the Army has long since carved out a huge bomber base near Lancaster, about 120 miles north of Los Angeles, and now Major C. C. Moseley has opened his War Eagle field about 10 miles west of Lancaster. This is a $500,000 airport at which 100 British boys are currently receiving flight training. Latest desert port, also in the Lancaster area, is projected by the Los Angeles county board of supervisors as an auxiliary field for transport and private flying operations. The desert is fog free and provides an ideal second choice terminal when fields closer to Los Angeles are closed by weather.

Wyoming Aircraft School

The Wyoming Aircraft School at Cheyenne, Wyoming, is now approved by CAA to give A. and E. courses. The school is under the direction of C. B. Jackson and has trained many men since it started in October 1940. Some $22,000 in equipment has been installed recently.

New Welding Booklet

A pictorial booklet, "You and Your Job in Arc Welding" has been published by the Hobart Trade School of Troy, Ohio. The booklet describes welding courses at the school and is free.

CAA Ground Training Plan

Seventy percent of men trained in airport ground classes by CAA, WPA, N.A.C.A. and the U. S. Office of Education have been able to get jobs immediately, according to Brig. Gen. Donald H. Connolly of CAA.

The Profile with a Point!

Every Allison-powered U. S. Army fighter is distinguished by the slender pointed nose you see in the picture below—the nose that helps make them as swift and agile in action as they look.

And this they've proved in the toughest test of all—in actual combat with the RAF—as you read in the news from the fighting front day after day.

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Curtiss	*P-40*	*Tomahawk*
Lockheed	*P-38 Interceptor*	*Lightning*
North American	*Apache*	*Mustang*

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DIVISION OF GENERAL MOTORS

Recent Books

FLYING FLEETS. A Graphic History of U. S. Naval Aviation. *By S. Paul Johnston,* 188 pp., illus. Duell, Sloan & Pearce, New York, N. Y., $3.00.

With world situations changing hourly, with so much that is new developing so swiftly, one must read quickly, and in ever-increasing amounts. This has necessitated an entirely new type of literature and one of its best exponents is S. Paul Johnston. His method of clear, terse presentation, shorn of superfluities, accompanied by sketches and photographs, would of itself be a recommendation. But back of the Johnston style is thoroughness and authoritative knowledge. Which is why we tell you not to miss his first book, "Horizons Unlimited", his new book "Flying Fleets", and his forthcoming book "Flying Fortresses." Flying Fleets treats of our Naval Aviation, not in detail, but graphically. He tells what is essential to maintain our protective ocean "fences". His inimitable grease-pencil sketches, seemingly jotted down, show clearly the job of our flying fleets and the organization pattern for the fleets. A portion of the text describes the types of naval aircraft and is broken down with one page devoted to each basic type, so indicated at the top of the page, which makes a handy reference. The history of the flying fleet is brief but all-inclusive, covered from all angles. The splendid collection of photographs, embracing every type of naval aircraft from Glenn Curtiss' box-kite of 1911 to the latest dive bomber, is broken down into groups of lighter-than-air, heavier-than-air, catapults, carriers, trainers and training, parachutes, and manufacturing.

Johnston's summation that "Naval aviation today stands ready to do its part in any emergency that confronts the nation. Our fleets that fly stand shoulder to shoulder with the fleets afloat in the defense of America" is borne out by his book, and should comfort those concerned about the defenses of our country. S. Paul Johnston is a Lieutenant Commander in the Naval Reserve, co-author of the "Aviation Handbook", former editor of AVIATION, and is now Coordinator of Research for the National Advisory Committee for Aeronautics. He knows whereof he speaks.

ARE YOU FIT TO BE A PILOT! *By Dr. Ermin L. Ray and Stanley Washburn, Jr.* Published by Wilfred Funk, New York. 61 pages, $1.75.

Here is an ingenious book which will interest a lot of people, both in and out of aviation. Dr. Ray is both a pilot and a Flight Surgeon. He has gone through the Army school for Flight Surgeons and has been stationed at Wright Field. Thus his material is authentic. In this book, written with Stanley Washburn of American Airlines, is presented in simple, interesting form, 12 tests for judging if one can pass a physical examination for a pilot's license.

Dr. Ray states that thousands of people never try to take up flight instruction because they think only supermen can pass the tests. This book was written to prove that nearly everyone can pass the tests. The various chapters are filled with clever charts for the reader to use. We recommend the book for all schools and airports, as well as for all persons who want to fly but who are not sure they can.

HANDBOOK OF SLEEVE BEARINGS. By *Albert B. Willi.* Published by Federal-Mogul Corp., Detroit. 218 pages.

The author is Chief Engineer of the Federal-Mogul Corp. and his book was written to be a practical guide for the engineer, designer and draftsmen in the selection, design and application of sleeve bearings. The book is divided into 10 sections, as follows: Materials of bearing construction. The precision insert (interchangeable) split bearing. Oil grooving. Special types of split sleeve bearings manufactured by his firm. Shims for adjustment of bearing clearance. Dimension sheets for precision insert split bearings; for plain and double flanged split bearings; for babbitt lined bearings; for precision "dualoy" full round plain and flanged steel back bearings; for flanged bronze bushings with stock in bore for finishing to six after assembly. Appendix.

INDUSTRIAL PLASTICS. *By Herbert R. Simonds.* Published by Pitman Publishing Corp., New York, Chicago. 385 pages, $4.50.

The second edition of an authoritative study of the use of plastics as engineering materials is comprehensive, yet simple and concise in its presentation. It will be valuable to engineers and enlightening to such of the general public who are interested in knowing what plastics are and their industrial applications so far.

Attractively illustrated with several color as well as numerous black and white photos, the book deals rather extensively with ten of the more important plastics, giving the physical properties and applications. A chapter on molding practice, using operations at the General Electric plastics plant in Pittsfield, Mass., as an example, should prove interesting. And in the chapter on Industrial Applications, a section dealing with plastics in airplanes will gain particular attention, although it is to be regretted more material could not be presented concerning plastic bonded plywood aircraft construction. It is, nevertheless, amazing the numerous and varied applications to which plastics are being put in this country and abroad.

AIR TRANSPORTATION. *By Claude E. Puffer.* Published by The Blakiston Co., Philadelphia. 675 pages, $3.75.

This scholarly book presents a complete and detailed analysis of all the activities of C.A.B. and C.A.A., the decisions of the Interstate Commerce Commission in air-mail cases from 1935 to 1938, studies the economic and legal characteristics of the air transport industry which bring it under federal regulations, and discusses the activities and powers of other governmental agencies which affect the airlines. Airline rates are thoroughly studied and discussed.

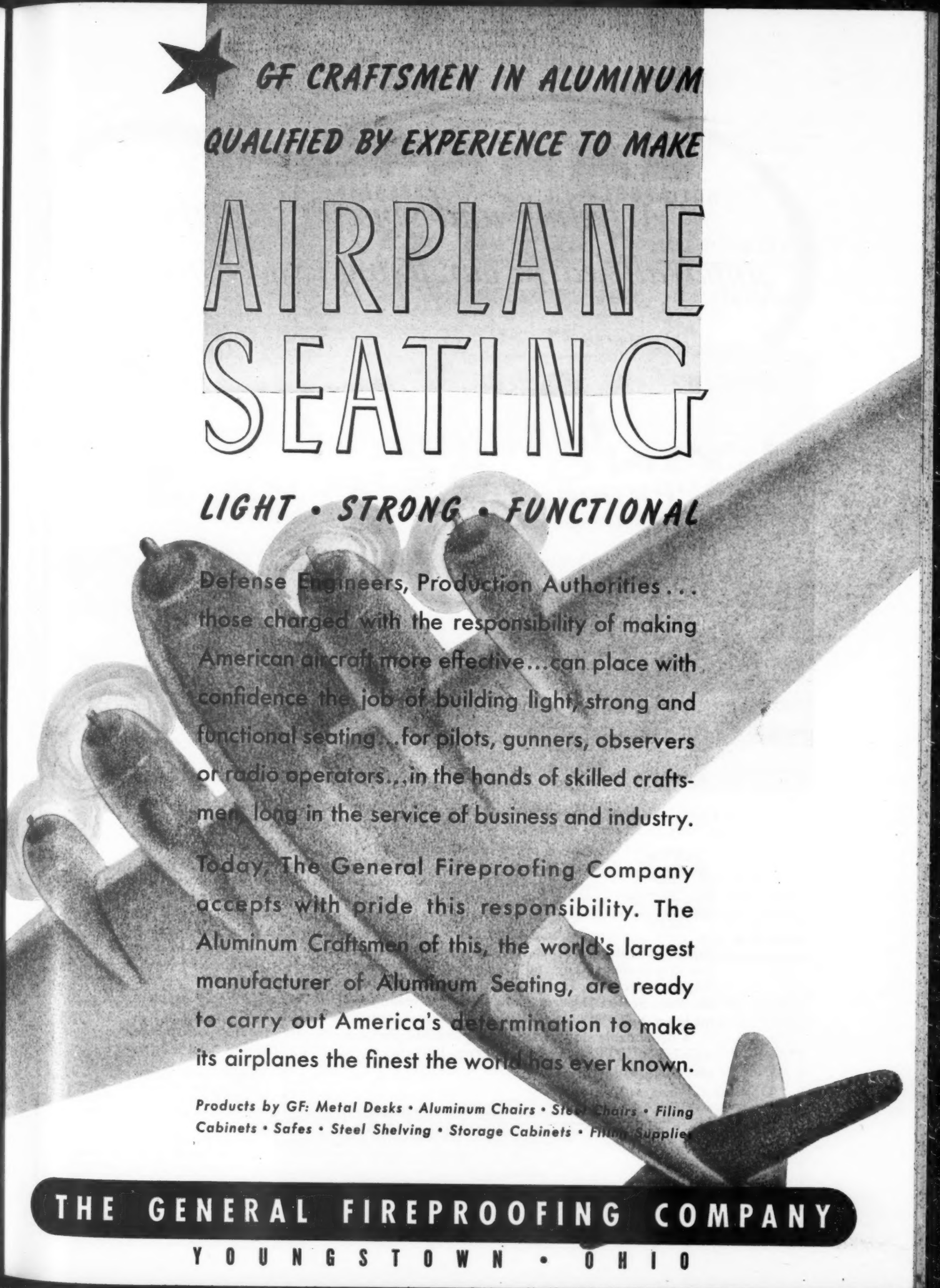
At about a half-cent a page, this book is a wonderful buy for anyone who takes his airline economics or history seriously. Thousands of hours of work have gone into collecting and presenting the material. The author is a Ph.D. and a member of the faculty at the University of Buffalo.

BOMBS AND BOMBING, WHAT EVERY CIVILIAN SHOULD KNOW. *By Willy Ley.* Published by Modern Age Books, 432 Fourth Ave., New York. 124 pages, $1.25.

The author is a German who came to the U. S. in 1934 and who is now editor of the New Weapons page of PM. In Germany he was president of the Rocket Society, and is an expert on incendiaries. He has made a close study of bombings in this war and passes on much new material to his readers. He discusses bomb sights, level bombing, dive bombing, AA guns, effect of bombs on skyscrapers, big bombs, and many other points. It makes interesting reading.

MAGNAFLUX AIRCRAFT INSPECTION MANUAL. *By F. B. Doane and W. E. Thomas.* Published by Photopress, Inc., Chicago. 193 pages.

The authors are a vice-president and an engineer of the Magnaflux Corp., and this is the official inspection manual for their company. Their book is clearly written, well illustrated and is a valuable contribution to aviation literature. The book covers all phases of Magnaflux work.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Chief Mechanic, Harry Grow, adds: "We appreciate the wonderful cooperation of the Waco Service Department in keeping us informed of the changes and improvements made on the UPF-7 Model Waco. Their service can't be beaten."

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To give only two examples, a Parks Aeronautical Engineering graduate, 6 years out of school, directed the wing development of one of the world's fastest pursuit planes now in mass production; a Maintenance Engineering graduate, 8 years out of Parks is Plant Superintendent of one of the important aircraft factories.

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Please send me details of four major courses in commercial aviation training.

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R.A.F. Bomber Crews

(*Continued from page* 53)

garden or some other spot which everyone would like to bomb, and the pupil adjusts his bomb-sight with many swift calculations. When he has finished his computing and dropped his bombs, a cross of white light on the floor, cast from a spotlight in the balcony, shows him where his bombs would have fallen.

The Link Trainer, ingenious invention of an American, Mr. Edwin Link, is, at a first glance, obviously a toy. An educational toy, perhaps, but the miniature aeroplane swaying very gently on a pedestal is painted so clean and brilliant a blue, with the rings of British aircraft patriotically bright, that it must be meant to catch the fancy of the pupil. And the object, the connection between this brightly painted model with death and destruction in Germany? At first, indeed, there seems to be no connection between the model and anything else at all. It does not seem to be connected with a small cupboard in one corner of the room, full of telephones and wires, from which an airman occasionally emerges, or with a table with a map on it and a complex machine, much like a mechanized planchette, poised on three wheels over the map. Nor does it seem to have any connection with the notice boards on the wall with scraps of paper pinned to them, each with a pattern accurately traced on it in red ink, a quatrefoil, the letter "H", or some other geometrical line—the young artist's first steps in drawing.

There is a subdued hum of hidden machinery and everyone in the room is busy and intent. It is a considerable surprise when the pupil himself makes his appearance, actually from inside the model aeroplane. A young Canadian with pilot's wings on his tunic lifts a black hood over the model and steps down from the pedestal, looking rather hot and tired and smoothing his ruffled hair. He has, in fact, done half an hour's very hard work, directing the course of the miniature aeroplane by instruments, with the black hood over his head. His course has been plotted by the planchette — it is called "the crab"—on the map which lies on the table, and he has been guided by the airman in the cupboard, who at intervals has sent him directions by wireless. His course when plotted on the map has traced out one of those geometrical patterns which are displayed on the notice board as an example to pupils; his flying has been as brilliantly exact.

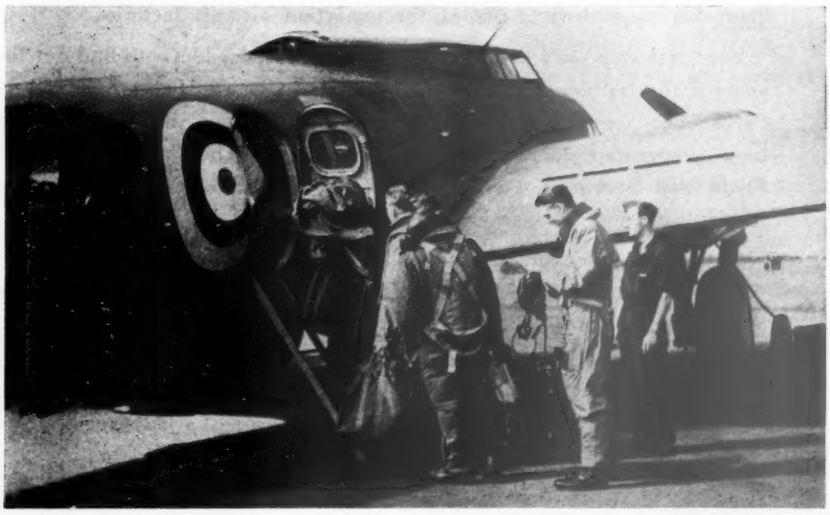
In another room in the training center, in the "cubicle trainer," a whole bomber crew works together in a dark cupboard in which there are all the essentials of a bomber's equipment. They look out at a screen on which a lantern from time to time throws slides of a German landscape as seen from the air. To make things more difficult for the crew, as things would be more difficult for them in reality, lights dazzle them as searchlights would, and little flashes on the screen mimic the bursting of anti-aircraft shells. Inside the cubicle the crew remains for hours at a time, in wireless contact with the instructor outside, with the pilot at the controls, the navigator plotting his course on the maps, the wireless operator getting signals from his base.

By degrees the crews move from models to reality. The air gunner learns to shoot both with real and imaginary bullets, always in a real gun turret mounted on wheels, but sometimes at a range and sometimes in a darkened room. In the "Spotlight trainer" he aims at the silhouette of an aeroplane which appears on an enormous dome of concrete resting on its side. His guns have no bullets in them, but only

(*Turn to page* 142)

Acme Newspictures

Bomber crews are taught how to get into a collapsible dinghy at night, in case the bomber is brought down at sea.



British Press Service

When training is completed the real work begins. This crew is entering a Boeing Flying Fortress for an attack on the Gneisenau lying in the harbor at Brest.

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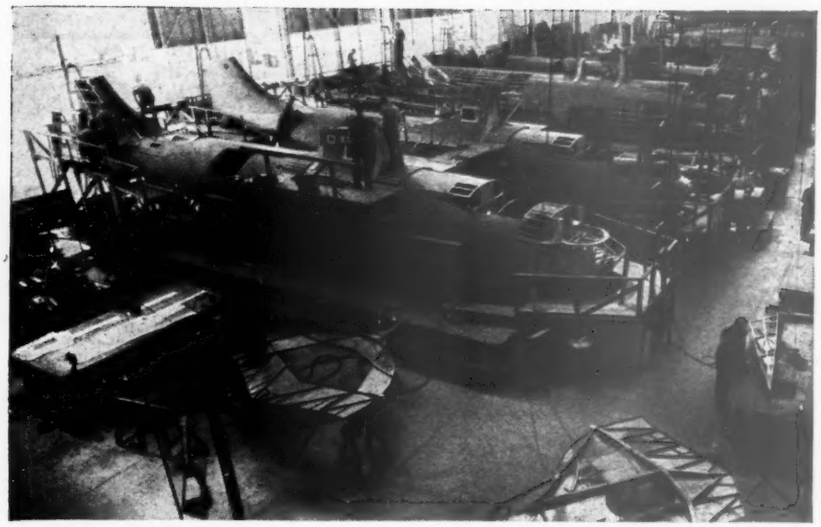

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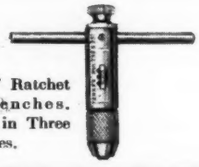

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Make good Mechanics Better
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(*Continued from preceding page*)

an electric light inside which shines on the dome when he fires. Here it is a very quiet warfare of light and shadow, but at the actual range the noise of the machine guns is shattering, an unbearable assault on the ear drums even though only one turret is firing at a time which is nothing compared with the noise of the eight machine guns of the Spitfire.

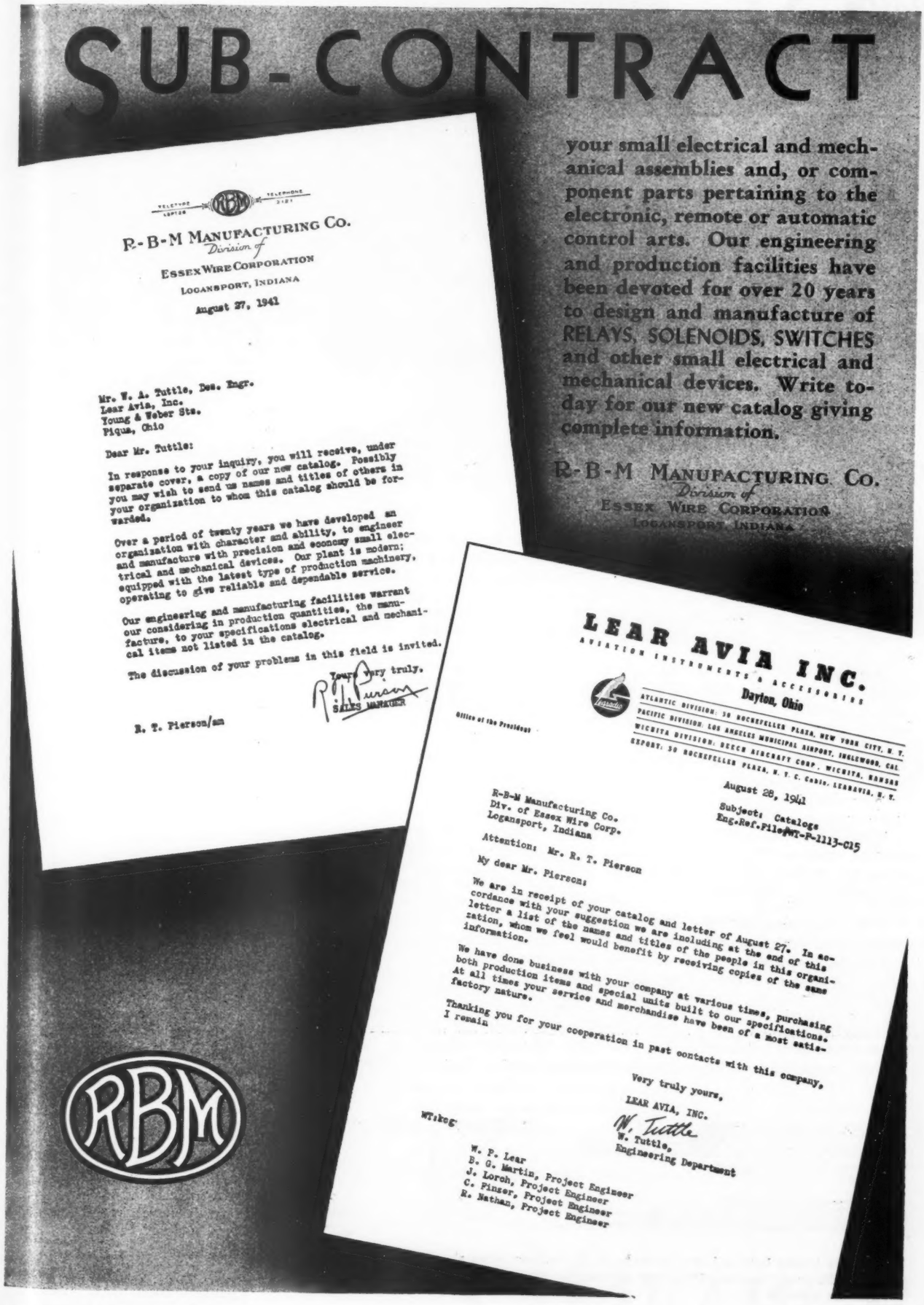
Here you can see what tracer bullets look like as they pass through the air; they do not look in the least like a moving particle of light, at any rate in the day-time, but there seems to be something, it is difficult to say what, cutting the air in two. Inside the heap of earth against the wall there is a little flame and a puff of smoke, a minute volcanic eruption caused by the bullets.

Later in their training the men go to the crew room, a long hut with lockers, much like a gymnasium, and strewn with what seems to be protective armour in which to play some unusually tough kind of football. They look young enough in their ordinary uniforms, but even younger in these ungainly overalls and helmets, padded, and hung with wires. All distinctions of rank are eliminated, as well as those signs and badges which give a due solemnity to military life. On the wall there is an encouraging poster telling the crews how much trouble will be taken to find them if they should happen to come down at sea. After a few last instructions they go out in lorries to bombers dispersed about the aerodromes. The bombers' airscrews begin to turn and there is a spurt of flame from the exhaust pipe and a violent sound of choking. Very slowly and rather clumsily the bombers waddle towards the runways of tarmac, turning corners with apparent difficulty, lumbering along until they reach the beginning of a great broad road across the aerodrome—in this weather, with the wet surface reflecting the sky, this looks more like a river.

Then the bomber begins to use the terrible power of its engines, and now it begins to look as though it were made to move along the ground, taking a very straight course, and quickly gathering speed. It has almost reached the end of the runway before there is any change and then the lift into the air scarcely seems as though it were meant to happen. After the fierce charge down the straight road flight is almost an anti-climax.

The crew has gone to drop bombs into the sea, dummy bombs filled with sand and containing a detonator to blow them to pieces. They are almost at the end of their training, getting

(*Turn to page* 144)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August 27, 1941
Mr. W. A. Tuttle, Des. Engr.
Lear Avia, Inc.
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Piqua, Ohio
Dear Mr. Tuttle:
In response to your inquiry, you will receive, under separate cover, a copy of our new catalog. Possibly you may wish to send us names and titles of others in your organization to whom this catalog should be forwarded.
Over a period of twenty years we have developed an organization with character and ability, to engineer and manufacture with precision and economy small electrical and mechanical devices. Our plant is modern; equipped with the latest type of production machinery, operating to give reliable and dependable service.
Our engineering and manufacturing facilities warrant our considering in production quantities, the manufacture, to your specifications electrical and mechanical items not listed in the catalog.
The discussion of your problems in this field is invited.
Yours very truly,
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EXPORT: 30 ROCKEFELLER PLAZA, N. Y. C. Cable: LEAVIA, N. Y.
Office of the President
August 28, 1941
R-B-M Manufacturing Co.
Div. of Essex Wire Corp.
Logansport, Indiana
Subject: Catalogs
Eng.Ref.File:WT-P-1113-C15
Attention: Mr. R. T. Pierson
My dear Mr. Pierson:
We are in receipt of your catalog and letter of August 27. In accordance with your suggestion we are including at the end of this letter a list of the names and titles of the people in this organization, whom we feel would benefit by receiving copies of the same information.
We have done business with your company at various times, purchasing both production items and special units built to our specifications. At all times your service and merchandise have been of a most satisfactory nature.
Thanking you for your cooperation in past contacts with this company, I remain
Very truly yours,
LEAR AVIA, INC.
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WT:kcg
W. P. Lear
B. G. Martin, Project Engineer
J. Loroh, Project Engineer
C. Pinser, Project Engineer
R. Nathan, Project Engineer
RBM

Aircraft Welding

(*Continued from page 67*)

jected to tension, compression or torsional test—whichever type of stress it is designed to withstand. The severity and completeness of each test depends upon available testing equipment and individual circumstances.

Again any difficulties which may arise are analyzed and any necessary changes in procedure are made. Suitable jigs are designed and built and the welding procedure marked on the blueprint. These markings include the starting and stopping points of all welds, the direction of welding and the welding technique. All operators are then required to follow that procedure exactly.

Weld Cross Section.

Edge Preparation. With material less than $\frac{1}{8}$ in. thick no special preparation is necessary except to make sure a good fit is obtained and that the edges are cleaned of scale, grease and other foreign matter. For material $\frac{1}{8}$ in. thick and heavier, the edges to be welded together should be beveled so as to provide an included angle of at least 75 deg., if possible.

Spacing. Most welds in aircraft work are fillet welds of one form or another and for this type of weld no spacing is needed. For butt-type welds the edges to be joined should be spaced somewhat to facilitate thorough penetration. This spacing at the point of welding should be at least $\frac{3}{32}$ in. for the lighter gauges to $\frac{1}{8}$ in. for plate material.

Weld Penetration. Thorough fusion between the base metal and metal added from the welding rod at all points in the weld is a necessary requirement of all fusion welding.

Weld Reinforcement. By reinforcement is meant the amount by which the weld is built up above the top surfaces of the parts being joined. Such reinforcement should merge smoothly into the top surfaces without undercutting or excessive build-up at any point. For butt welds in S.A.E. X4130 sheet or tubing welded with low-carbon or medium-carbon welding rod, the weld should be built up so as to be at least $1\frac{1}{4}$ times the base-metal thickness. With relatively thin base metal, 0.10 in. and thinner, the weld, including the reinforcement, is frequently as much as twice as thick as the metal being joined.

Welding Rod. Like most other welding operations, X4130 is joined with a welding rod having an analysis different from that of the base metal. Three commonly used welding rod analyses

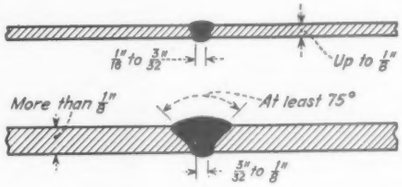


Fig. 3—Blacked-in areas indicate the desired contour both at the top and at the root of the finished weld. Naturally, with light gauges the reinforcement may be as much as 100 percent, instead of the 25 percent indicated here.

will be given here and the chief reasons for the use of each will be explained.

The welding rod that has been used most widely until recently, and that is still used for much aircraft work, is a low-carbon steel similar to Norway iron. The general analysis is given as 0.06 percent carbon max., 0.25 percent manganese max., and not over 0.05 percent silicon. (Oxweld No. 7 Drawn Iron Welding Rod, copper-coated, meets this specification.)

Naturally such welding rod has considerably lower unit tensile strength than the X4130 base metal. However, welds having equal or greater strength than the base metal are consistently made in light gauge material. Two factors contribute to this strength:

1. The thickness of the weld metal, the weld cross-section, is considerably greater than that of the base metal.

2. The weld metal, during fusion, picks up alloying elements from the adjacent base metal, thereby increasing the strength of the weld metal. At the same time the slight decrease in base metal strength, due to the loss of alloying elements, occurs in an area strengthened by the weld reinforcement.

When aircraft tubing greater than 0.10 in. thick is to be welded, an excessive height and width of reinforcement would be required to obtain strength in the weld equal to that in the base metal with the low carbon welding rod. Furthermore, because of the greater spacing between the base metal parts during the welding of this thicker material, the pick up of alloying elements from the base metal is not as uniform in its effect upon the weld. These factors indicate the need for a welding rod of higher strength. Therefore, a welding rod having 0.13 to 0.18 percent carbon, approximately 1.10 percent manganese and 0.25 percent silicon (Oxweld No. 1 High Test Steel Welding Rod) has found wide acceptance for some time and its use seems to be expanding. In addition to the higher strength of this rod due to its increased carbon content over that of the low carbon rod previously mentioned, the manganese and silicon in this welding rod have a fluxing action which is advantageous. The carbon content in this rod offers the opportunity of increasing weld strength by heat treatment.

(To be continued in an early issue)

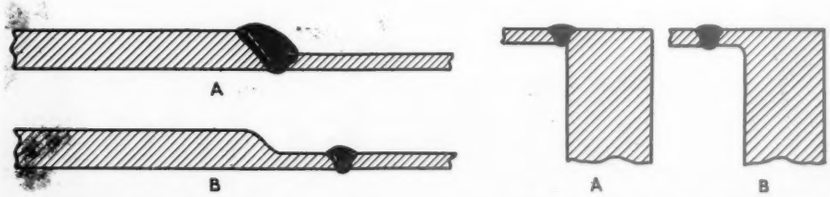


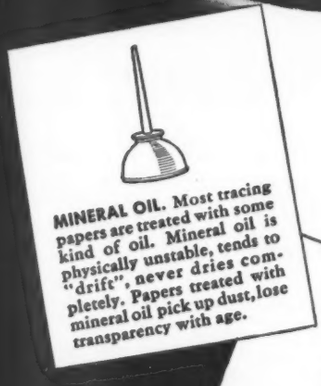
Fig. 4—In joining light to heavy sections, A, the welding flame should be directed more against the heavy section. Suggested methods for making the joining of such sections easier are given at B.

R.A.F. Bomber Crews

(*Continued from page 142*)

very near to the real thing and anxious for it to begin. They have had enough of training by now, not only here, where they have learned to work as a crew, but in other schools before, where they were trained as individuals.

Back from their training flight they take a rest before dinner, still loosely divided into crews, for the crews have a way of sitting together even when not at work. There are dark blue Australian uniforms mixed with the lighter blue of the R.A.F., which Canadians, New Zealanders, South Africans and men from all parts of the Empire wear. There is one man who has come from South America on his own to fly in a bomber against Germany—he wonders at intervals if the R.A.F. would like to pay his fare but he does not expect anything much to be done about it in the near future. There is a very young man dozing in a wicker chair; with a kitten asleep on his knee. He has the rather long hair which flying men often wear and he looks much like an English undergraduate, lazy after a day on the river. Nothing but war would easily have brought these men together, but now they are together indeed. There are few closer ties than those which hold together the crew of a bomber.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VEGETABLE OIL, chemically unstable, oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

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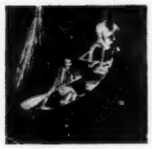

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Plated Aluminum

(*Continued from page* 84)

Naturally, this application brings forth the possibility of flexible engine mountings made of duralumin rather than with steel. A large saving in weight could thus be effected and it is interesting to point out the possibility of this application is already being aggressively followed by certain aviation manufacturers.

Experiments are also being conducted in connection with the possibility of hard-chrome-plated aluminum propeller blades. Here it may be necessary to go to chromium deposits that may run as high as five- or ten-thousandths of an inch in thickness. Inasmuch as there are only two materials in the world that are harder than chromium (the diamond and boron), it is quite possible that heavy deposits of this extremely hard metal may help to overcome some of the problems of the high-speed aluminum propeller blades.

Still another possibility of plated aluminum in the aircraft field, is the prevention of seizing in connection with male and female threaded members used in aerial "plumbing" systems. The effect of slight deposits of cadmium and zinc on such plated pieces is now being studied with a view of eliminating the trouble that has been had in such places.

Nickel plated duralumin crankshaft plugs are already in use in the aviation engine field and here the highest authorities in the field have specified the use of such material.

Experiments now being conducted in connection with aluminum pistons and cylinders would indicate that perhaps some day it will be possible to build a cheap all-aluminum engine in which both the piston and the cylinder will be made up of some aluminum alloy over which heavy deposits of nickel and chromium have been placed. Experiments that have been conducted by one of the largest automobile manufacturers in the country indicate that aluminum pistons, at least, can certainly be made available to the automotive industry through the deposition of small amounts of nickel and chromium.

Perhaps there are many aeronautical instruments and parts now made of steel and other metals that could be made of aluminum, providing it could be given a wear-resistant surface. Even small amounts of nickel greatly increase the capacity of aluminum surfaces to take wear and when a thousandth or two of chromium are placed over the nickel, extremely good wear resistant surfaces are created.

Certain authorities in the plating field now claim that aluminum plated with cadmium directly shows salt spray corrosion tests that exceed the protection of anodically treated aluminum surfaces. Even aluminum plated with nickel has shown salt spray resistance up to 6,024 hours, which is several hundred percent over the best figure that can be shown by aluminum anodized by ordinary means.

The possibility of using aluminum or duralumin commutators on aircraft motors and generators is also being actively investigated. After having been plated with nickel, the segments could be soldered in position with the connections and after assembly the whole commutator could be covered with chromium which would not only produce extremely long wear, but would also be highly resistant to oxidation.

All in all, it is quite obvious that the aircraft industry has discovered an extremely helpful ally in connection with plated aluminum and that, as time goes along, more use will be made of it.

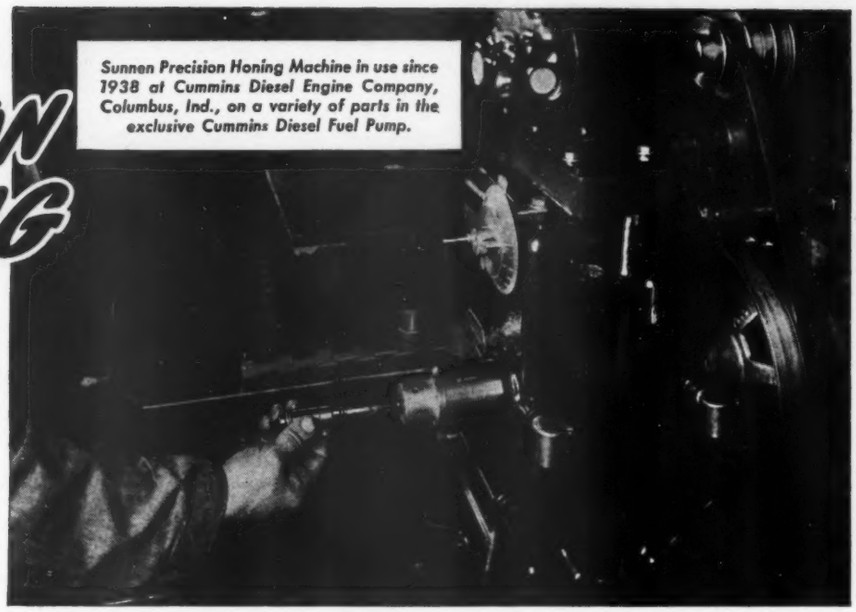
Arrangements are being made for the plating of aluminum extrusions in 24-ft. lengths, and once the pressure on the aluminum raw metals market has been lifted, a great deal of this material will become available for aircraft use.

When plated aluminum is mentioned to technical men, the questions immediately suggested are: what does the adhesion amount to and what are the corrosion tests?

After a number of years experience with the process, it can now be definitely stated that nickel and a host of other platable metals can be adhered to the surface of aluminum and its alloys much more effectively than they can be adhered to such metals as zinc or steel. Insofar as adhesion is concerned, aluminum can be plated better than the two metals mentioned and as well as any other metal.

Corrosion resistance, of course, depends upon many factors: upon the nature of the basic metal, the metal plated over it, the thickness of the metal over it, corrosion agent and its temperature, etc. The nature of the surface of the basis metal can also be a factor; that is whether (in the case of aluminum) it is sand cast, die cast, extruded, rolled, or forged. Ordinary sand castings covered with .001 in. give the normal resistance to 20 percent salt spray tests; that is from 100 to 300 hours. On the other hand .001 in. of nickel well plated on dural surfaces have given as high as 624 hours salt spray before a rupture in the plated surface appeared. Over 600 hours have been recorded before pitting appeared over a wide area.

SUNNEN PRECISION HONING



Sunnen Precision Honing Machine in use since 1938 at Cummins Diesel Engine Company, Columbus, Ind., on a variety of parts in the exclusive Cummins Diesel Fuel Pump.

Contributes to the Fuel Pump Accuracy of Cummins Diesel Engines

● The picture above shows the Sunnen Precision Honing Machine finishing fuel pump barrel for the metering plunger. The plunger diameter is held to a tolerance of .0002".

Here's another example of how Sunnen Honing is serving manufacturers—especially those holding important defense contracts.

Solves Five Important Problems

1. Corrects errors of out-of-round and taper produced by previous operation.
2. Produces super-smooth surface finishes.
3. Accurately finishes holes to very close tolerance as to size and straightness.
4. Maintains alignment already established by previous operations.
5. Provides a simple, low cost production method for accurately duplicating sizes.

Wide Range of Uses — The Sunnen Model "MA" Four Speed Precision Honing Machine will handle any size hole from .185" to 2.400" in diameter in any metal except lead or babbitt.

Saves Time because it can be set up for any size job and ready to go in less than a minute—no locating.

Saves Money — Low in initial cost (basic price only $195); economical to operate; requires only semi-skilled labor.

Saves Man Hours — Saves training time—any intelligent young man can learn to do precision work in 24 hours.

Saves Power — Uses only 1/3 hp—relieves big grinders and other machine tools for other work.

Accurate — Accuracy within .0001" guaranteed.

Let Us Help You Solve Your Problem.

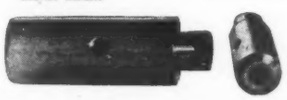
In the column on the left we show a few typical jobs handled on the "MA."

Write for the new 8-page bulletin giving complete information — or if you prefer, a Sunnen Sales Engineer will call and demonstrate the Sunnen Precision Honing Machine in *your* plant on *your* job. Write today.

Typical Uses

Drawing and Blanking Die "Saves time in producing smooth base metal finish."

Inner Bearing Ring "Accurately removes last 'tenth' of stock."



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"A perfectly straight round hole with a mirror finish."

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Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improving the quality of the bearing surface they contact. An extremely smooth surface-finish was secured.

"Produced an extremely accurate and glass-like finish."

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Auto-Makers

(*Continued from page* 49)

efficiency of operation, entirely new concepts of weight-strength ratios have evolved. However, reduction of weight in surface carriers does lead, though in lesser degree, to greater efficiency with resultant economies, as has been learned by the makers of buses and streamlined railroad trains. It is reasonably safe to assume that motor cars of the future will be constructed with greater strength and overall lightness, due in part to developments pioneered by the aviation industry.

Fundamental Differences in Production

Now let us look at the production problems. Under the 40,000 plane program there are roughly 40 different models in production and on order, a general average of 1,000 per model. Even with the utmost effort to achieve maximum standardization, it is unlikely the number of models could be reduced to less than around 35 without seriously jeopardizing the military efficiency of our Army and Navy air forces. The requirements with respect to quantities of various models vary widely, of course, but even the demand for those types needed in greatest numbers will scarcely approach 5,000 a year in the immediate future. There is a strong possibility that the numerical strength of air forces may tend to diminish in the future as the trend-curve toward larger unit sizes has as yet shown no tendency to flatten out.

Five thousand units of one model a year is less than 20 units per working day. Some automotive producers have a capacity of *2,000 units a day*. Anyone who thinks 2,000-units-per-day production methods can be applied to 20-units-per-day production is simply uninformed on the subject. Moreover, 2,000-units-per-day capacity was not established in 6 months, a year, or two years. It is the culmination of many years' experience in gradually expanded production of a standardized product with only minor modifications once or twice a year. More substantial changes completely disrupt the production processes.

In military aircraft, the maintenance of superiority in quality and performance is fully as important—possibly more so — than relative numerical strength. Hence, every improvement or modification of airframe, engine or accessories and equipment, as soon as it is proven, must be incorporated right *now*, not next season or next year. And because the airplane is such a closely integrated and delicately balanced instrument from nose to rudder, seemingly minor changes frequently involve extensive redesign which would be unnecessary in other vehicles. If production facilities were "over-tooled" the attempt to incorporate essential improvements would cause far more serious delays in deliveries than is the case at present. Furthermore, one of the most serious hindrances in the industry expansion has been in the procurement of machine tools; any extension of present "tooling-up" plans might result in dangerous further delays in ultimate deliveries.

Future Implications Important

Thus the intent was not to adopt the methods of the auto industry when the aviation program expanded into that field, but to adapt the facilities and skills of that industry to the requirements of aircraft production.

Meanwhile, real progress is being made toward immediate goals. Only the major facts of automotive participation are stated in order to present a clearly proportioned picture within reasonable space limitations. The picture is changing in outline and detail every day; changes will have occurred between the time of going to press and publication. And now, since more than two engines and propellers are needed for every airplane built, let us take a look first at the potential power plant production of the automotive industry.

The Engine Program

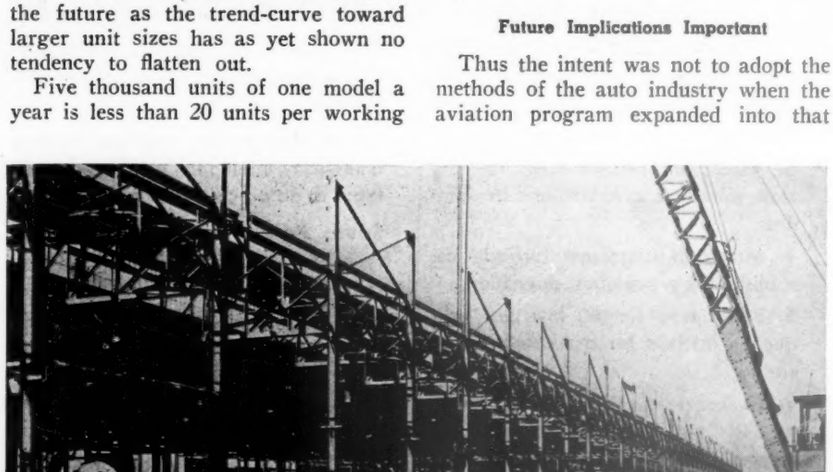
General Motors Corp. is the largest participant in the aircraft engine program, with its Allison Division at Indianapolis and Pratt & Whitney engines to be produced under license by Buick at Melrose Park, near Chicago, and Chevrolet at Tonawanda, N. Y. Another licensee, not in the automotive field is the Jacobs Aircraft Engine Co. of Pottstown, Pa., for which the Defense Plant Corp. is erecting a $13,000,000 plant, to be operated by Jacobs under a lease agreement.

The Allison liquid-cooled engine, of course, has been under development by GM for many years, but only in the current year has it been brought to the degree of perfection represented by the 1325 hp. model now in production. Nor was large-scale production achieved until this year, but now Allison is well on the way to the long-sought goal of 1,000 engines per month, successfully meeting demands imposed by production of fighters using this engine. The Cadillac Division of General Motors is an important subcontractor.

Allison plants at the Indianapolis site occupy more than a million and a quarter square feet of floor space and employees number about 10,000. At last report, Allison held defense orders totalling approximately $242,000,000. The rated output of the V-12 will be increased again, probably to around 1500 hp. without major redesign. The 24-cylinder four-bank Allison turning up in excess of 2,600 hp. awaits only an airplane to carry it for production to begin.

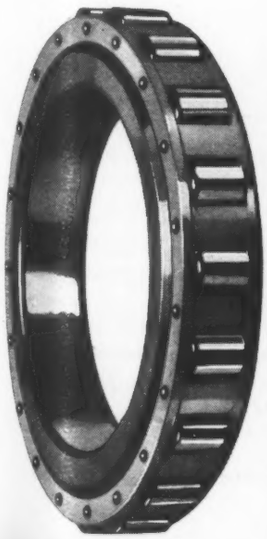
Buick is in the early stages of production on the P & W 1200 hp. Twin Wasp at the Melrose Park plant which is now about completed. By the end of the year production will be in progress and will gradually swell on into 1943. Soon, 15,000 workers will be employed on this project, two-thirds at Melrose Park and the other 5,000 at the parts plant in Flint. Buick holds $123,200,000 worth of orders.

(*Turn to next page*)



At this huge new plant in Akron, the Goodyear Aircraft Corp. will turn out a variety of airplane parts, including sub-assemblies for the Martin B-26 to be assembled in Omaha, Nebraska. Other production is already in progress in the nearby airship dock.

Aircraft Bearings by Bower



Propeller Shaft

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An interesting full color, 4-page folder featuring Bower advantages to national defense.

Building wing flaps for North American B-25 bombers at General Motors' Fisher Body plant in Memphis, Tenn. Parts go to the North American plant in Kansas City, Missouri.

For the past several months Chevrolet has been busily engaged in preparations for manufacture of an $88,000,000 order for additional P & W 1200 hp. engines. The War Department in September approved lease agreements with Chevrolet for establishment of plants and facilities at Buffalo and Tonawanda at a cost of $37,161,530 for this purpose. Chevrolet engine production will not get under way until late in 1942.

Ford Motor Co. is now in production on the Pratt & Whitney 2000 hp. radials which are destined for installation in the C-46, the Curtiss-Wright Army transport, and fighters such as the Republic P-47 Thunderbolt. These engines are produced at the big new River Rouge plant constructed for the purpose. Ford started production on the first engines by the end of summer and hopes to reach a rate of 40 per day next year.

Packard Motor Co., building Rolls Royce "Merlins", has an assembly line in operation but it is not anticipated volume production will be reached before spring. It is understood the output of this engine has been stepped up to about 1300 hp., which gives it a more favorable weight-power ratio than ever. Packard has a backlog of more than $200,000,000 in British and American orders, and expects to have about 17,000 men employed by spring.

Studebaker Corp. will build 1700 hp. Wright radials, and some in the 1200 hp. category. For this purpose three new plants have been constructed, comprising over 1,500,000 square feet of floor space. Chicago and Fort Wayne plants will supply parts to the main assembly plant at South Bend. The plants cost approximately $50,000,000, supplied by the Defense Plant Corp. Tools have been moving into all three plants for some time and production will be under way early in 1942. Present schedules call for completion of 600 engines monthly by May.

Continental Motors Corp. at Muskegon, Mich., has for some time been in quantity production on 250 hp. engines for training planes and light tanks, and 75 hp. engines for primary trainers. Continental's Detroit subsidiary is in production on 450 hp. Wright Whirlwinds for airplanes and tanks.

Many New Engines Under Development

Although information is restricted concerning research on aircraft powerplants, the following facts can be divulged. The Ford Company is known to be encouraged with progress on the V-12 air-cooled engine of its own design. It is expected to turn up 1600 or 1700 hp. Ford has been conducting extensive research in attempts to produce a centrifugally cast cylinder sleeve to replace forgings or tubings now utilized. If these efforts succeed, many vexing problems in aircraft engine production will be removed.

Briggs is reportedly working on a powerplant of higher output than anything which has yet appeared. Chrysler has one or more experimental airplane engines in its laboratories. Packard engineers are working on a 2000-hp. engine of their own design, and Continental's Detroit branch is working with the Army on a new high-output engine. Allison has even more powerful engines than the 24-cylinder job under study.

Extensive Subcontracting Involved

It is impossible in this article dealing largely with primary contractors to discuss subcontractors except where such activities on the part of major auto companies render it pertinent to the subject. It must be understood, however, that the industry is involved to a far greater extent than is described here. There are many hundreds of active subcontractors in the industry program, some of the primary contractors employing up to several hundred subcontractors on a single product. The varied origin of components of a single product and the criss-crossing lines between divisions of a single concern and separate organizations presents an industrial picture of vast complexity. But it is just this flexibility and the concomitant opportunities for spreading expansion evenly throughout a vast industry that is enabling the automotive industry hopefully to work toward aeronautical production of the truly enormous proportions involved.

The new $37,000,000 Wright plant near Cincinnati now getting into production on Cyclones is relying heavily on the auto makers for parts. Hudson is supplying all rocker arms and pistons for these engines. Several million dollars worth of business is involved. Graham-Paige is producing engine connecting and articulating rods for the same product to the extent of about $10,000,000 worth, and Ohio Crankshaft and Eaton Manufacturing are supplying crankshafts and propeller shafts, respectively. Numerous others also are contributing products from their extensive automobile experience.

The Propeller Makers

Aeroproducts Division of G.M. at Vandalia, Ohio, is getting into production on a $71,800,000 order for variable-pitch propellers designed especially for Allison engines. Around a thousand men are employed in this new plant and employment will swell to 2,500 at peak production. Embodying several new features, this prop is made with hollow blades of ribbed, heat-treated steel. The hydraulic operating mechanism is housed in the hub and base of the blades so as to permit center-mounting of an aircraft cannon which fires through the hollow shaft.

Nash-Kelvinator Corp. will make Hamilton Standard propellers under license by United Aircraft. Old plants of Reo Motors at Lansing have been reconditioned for this purpose and employment is expected to reach 3000 some time next spring.

Ford will be the largest automotive

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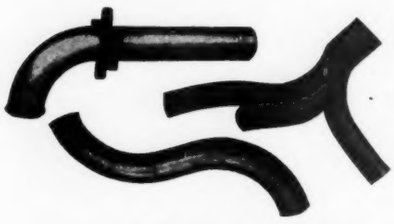

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participant in the airplane program with a scheme which contemplates the building of 75 completed Consolidated B-24 long-range bombers per month and parts and sub-assemblies for an additional 100 planes of the same type to be completed at the Government assembly plants under construction at Fort Worth, Tex., and Tulsa, Okla. To this end, construction is being pushed rapidly on the $47,000,000 Willow Run project which Ford claims will be the largest aircraft factory in the world producing a single type of aircraft.

A 975-acre site near Ypsilanti, Mich., will accommodate airport, hangars, power plant and offices in addition to the assembly building and machine shops. Total floor space, exclusive of hangars, will run in excess of 2,500,000 square feet, and probably in excess of 50,000 workers eventually will be employed there. Structural work on the assembly building and the chief machine shop is largely completed and construction work is well advanced on the airport and other units. But even so it is unlikely that operations of any magnitude can get under way until the latter part of 1942. Ford orders for aircraft are nearly $500,000,000.

G.M.'s Fisher Body Division is in production on fuselage sections and parts for the North American B-25 medium bomber. The major portion of this work is being done at the new Memphis plant, although Fisher plants in many other cities are contributing. Over 3,000 men are now employed and eventually the number will exceed 9,000. Fisher holds a $78,000,000 order for B-25 parts and expects to be in full production when the government's Kansas City assembly plant gets under way by February or March of next year.

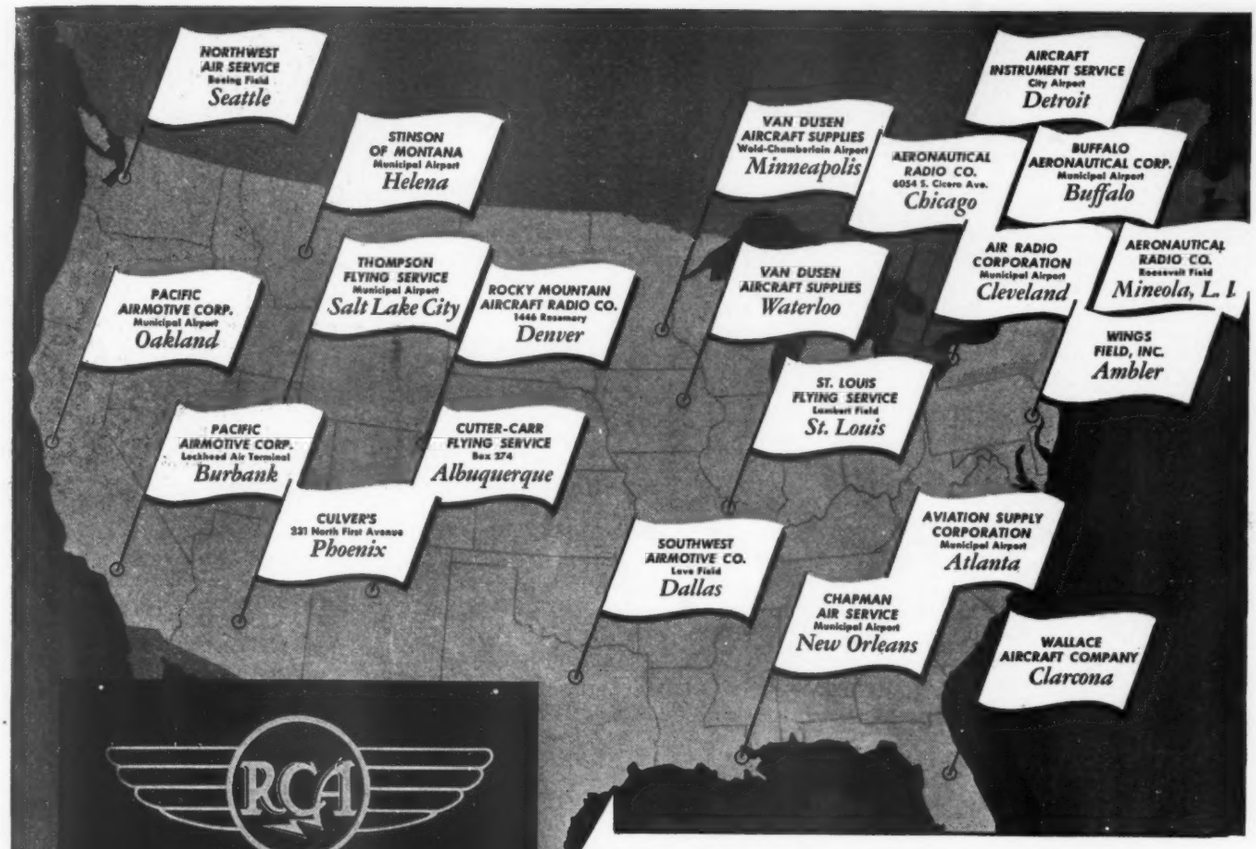
Chrysler Corp. and Hudson are both under contract to build fuselage sections and parts for the Martin B-26 medium bomber. Both concerns are in the preliminary engineering stages of preparing tools, jigs and dies. Chrysler has a $42,000,000 order to produce nose and center fuselage sections. Several Chrysler plants in the Detroit area will engage in this work and final assembly will be conducted in the Warren avenue plant formerly occupied by Graham-Paige. Chrysler estimates well over 10,000 employees will be engaged in this work. Hudson will produce tail assemblies and fuselage parts. Both these firms will get into volume production early next year to coincide with the start of B-26 assembly at the Omaha plant now under construction.

Goodyear Aircraft Division, though not an auto manufacturer, is included because of the large role it plays in the bomber program and the impressive volume of other airframe work. Naturally, other rubber companies are playing important parts in the aviation program, too. A new plant at Akron now nearing completion will be devoted to fabrication of outer wings for the Martin B-26. Production already is in full swing on all control surfaces for the B-26. Goodyear also is in production on control surfaces for the Martin PBM navy patrol boat; outer wings, wing-tip floats, ailerons and tail assemblies for the Consolidated PB2Y long-range patrol boat; metal stabilizers for the Curtiss P-40; tail surfaces for Grumman F4F fighters, and a diversity of wheel and brake assemblies. By late spring Goodyear expects to have 9,000 employees in aircraft work.

Briggs Manufacturing Co. is in production on outer wings for two types—the Douglas A20 light bomber and the Vought Sikorsky F4U fighter—and a great variety of ducts, bomb doors, fuel tank covers, wing flaps and other parts for the Boeing B-17 Flying Fortresses. Briggs holds over $40,000,000 worth of aircraft orders and was one of the first companies in the industry to reach volume production in work of this kind. Murray Corp., second of the major body builders in the Detroit area, is in active production on fuselage sections and parts for the Douglas A-20 and tail surfaces for the Brewster Aircraft Co.

That, in broad outline, is how the job is being done. On the whole the program is ahead of original schedules, but there has been so much doubling and redoubling of expansion projects that schedules are relatively meaningless. It isn't all smooth sailing, though. There are headaches, delays, blunders and bad guesses galore as there must be in all human undertakings. But the overall magnificance of this gigantic effort, seen at first hand, coupled with the prevailing enthusiasm of management and workers justifies optimism and confidence in the ultimate outcome.

True, there are many imponderables with respect to the future of aviation after the present emergency is over. But most of them are on the bright side. The surface of air freight transportation possibilities has scarcely been scratched. The improvements already incorporated in aircraft as a result of expedient military requirements will have rendered obsolete and economically unfeasible to operate every transport on all the airlines of the world. We will have pilots by the hundreds of thousands, great numbers of whom will be eager to obtain airplanes offering reasonably safe and efficient performance at prices within their means. Certainly difficult days are ahead. But the picture is by no means dark, particularly if we, as a nation, will exploit to the fullest all of the positive factors just as soon as they are perceived. That means coordinated planning from now on.



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RCA *for Aviation Radio*

RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

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Langley Airplane

(*Continued from page 76*)

Vinyls, which are thermoplastic, have also been found to be stronger, lighter and more reliable than the thermosetting resins such as the phenols and ureas. The thermoplastics may be compared to steel, aluminum, etc., in that they may be melted and worked into shape over and over again like the metals. On the other hand, the thermosetting plastics are like concrete, and may not be reworked once they are set, and like concrete they are brittle.

Forming Structural Parts

For given strength, the makers claim their molded plastic bonded plywood provides the lightest construction known. The molded parts of the Langley ship are multiple layers of veneer formed over a mold and permanently bonded together into a complete structure. Each of the integral members — fuselage, wings, control surfaces and cowling — are joined without any mechanical fastenings such as nuts, bolts or screws.

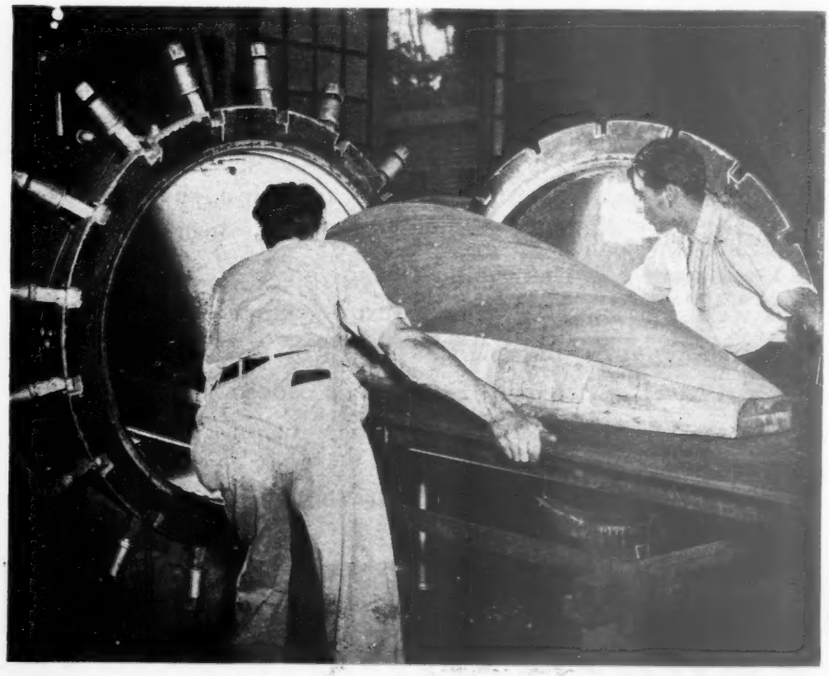
The parts are made on relatively simple wooden molds, strips of veneer being placed over each other upon the forms while dry. In producing the Langley plane, the following molds are used: right and left fuselage halves; center section; two outboard panels; two aileron molds; horizontal stabilizer; vertical fin; rudder and elevator molds; engine cowl (upper and lower); engine nacelle (upper and lower); and two streamline fillets, which are fitted between upper wing root surface and fuselage.

The laminations of mahogany veneer are built up to the desired thickness for the part and held in place by clips or nails, each lamination receiving a coating of resin. The part is then "cooked" at a certain temperature and pressure, the resin fusing and bonding the several laminations together so strongly that the only means of separating them is complete destruction of the part.

In forming veneer laminations over the curved surface of a cowl prior to molding, for instance, the strips of mahogany are stapled down in place with a special, light hand stapling tool which punches through the strip and into the wooden mold, thus holding the strip in place. And in order to cause the strips to fit snugly to the mold without bulging as they are fastened to the curved surfaces, they are split with a short knife-like tool, pared to fit, and stapled into place, where they lie flat. As each succeeding layer is put on, the clips are removed from the under layers.

When the mold is entirely covered with the desired number of laminations, each being coated with vinyl resin, the part is then "cooked," thus bonding all the laminations permanently together in the shape of the cowl. Upon examination, each strip is found to have fused so closely to the one next it that the surface appears as one continuous sheet. The tendency of the plywood after molding is to retain the shape imparted by the mold, however acute the curve may be, as the natural form, for the fibers of the structure are molded, not bent, into shape.

In forming strips of mahogany veneer over an engine cowl, a special hand stapling tool is used which punches through the strip and into the wooden mold. As each succeeding lamination is put down, the staples are removed from the under layers.



When a structural part is ready to be molded, it is encased in a rubber bag, placed on a wheeled tray mounted on tracks, and run into the oven for "cooking" under pressure. Here in a specially posed picture is shown how a nacelle is run into the oven, although actually it would be placed in the rubber bag before being molded.

In "cooking," the structure (fuselage, spar, cowl, etc.) is placed in a specially constructed rubber bag from which the air is exhausted. Care is taken to prevent wrinkles in the bag from remaining in contact with the structure on the mold, not only to avoid wear on the bag, but also to avoid having the wrinkle pressed into the plywood. The bag and its contents are then run on a wheeled tray mounted on tracks into a long cylindrical oven to be "cooked" over a period of time depending on the size and thickness of the structure.

The compression method used is called fluid pressure—air, steam and water—which gives equal pressure in every direction. While under pressure the structure is heated to a certain temperature and later water-cooled; the entire process in the case of the fuselage-half consuming approximately three hours.

The wing is of two spar construction and follows conventional design in its structure; i.e., no attempt has been made to build a "hollow" wing, for instance. Ribs, spars and skin, however, are molded together into one piece. The tapering spars are exceptionally strong and light, and may easily be picked up with one hand.

Only one operation, or "cooking," is necessary to complete an entire fuselage-half—bulkheads, stringers and skin are

THREE crowded assembly lines of twin-engine, all-metal BEECHCRAFTS show the results of one year's expansion for Defense production at the Beech factory.

These results are further apparent in the following comparisons of production and related activities at Beech for October 1st, 1940 and October 1st, 1941:

Deliveries during September 1941	702% of September 1940 deliveries
Inventories of raw materials and work in process October 1st, 1941	670% of October 1st, 1940
Total available floor area	550% of October 1st, 1940
Total employees	403% of October 1st, 1940
Backlog of uncompleted work	390% of October 1st, 1940

Deliveries for the company's fiscal year 1941, which ended September 30th, are 430% of deliveries for fiscal 1940, after adjustment to a common basis. September 1941 deliveries alone are practically equivalent to total deliveries for the 1940 fiscal year, allowing for the value of engines and equipment furnished by the Beech Aircraft Corporation during 1940, and not thus furnished during 1941.

The much larger percentages of increase in deliveries and inventories than in floor space and total employees show the attainment of increased operating efficiency. Further increases in efficiency are within immediate reach, as the result of a continuous employee training and upgrading program. Present production is as yet only a fraction of the ultimate planned production level, which should be reached by March 1942. Unfilled orders on hand now total approximately 88 million dollars.

Information regarding all commercial BEECHCRAFTS known to be on the market is available from the Used BEECHCRAFT Exchange, a service maintained for the benefit of present and prospective BEECHCRAFT owners.

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Penco "3-Shift" Tool Stand for 24-Hour Service!

Keep tools right on the job—twenty-four hours a day. Each of the three drawers locks separately—a single drawer for each shift. Amazing time saver!

All-welded steel construction for heavy duty service. 32" high, 30" wide and 18" deep. No. 12 gauge shelves—flanged top. Drawers 5" high, 18" wide, 16" deep. Also furnished with one or two drawers.

Here is portable and protected storage in a tool stand with the utmost in convenience and time-saving features. Designed for defense work and available in quantities only. Write for attractive *quantity* prices.

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32 Oregon Avenue, Philadelphia, Pa.

all molded together into an inseparable bond. Skin thicknesses of the fuselage are never less than three laminations of veneer; where stresses are greater, more laminations are employed. In final assembly, the fuselage-halves are fitted together and fastened with a thermosetting phenol glue.

As skin and internal structure are molded into one piece, no rivets, nails, or screws are needed save where the part is purposely made detachable, such as the wing tips, engine cowling and nacelles.

The plywood is highly fire resistant. It will burn, but will not alone support combustion. This was demonstrated when a plywood section comparable in weight to sheets of aluminum alloy and stainless steel was subjected to an acetylene torch test. Although the torch, which can generate enough heat to melt concrete, cut through both the stainless steel and aluminum alloy in two seconds each, it required 7½ seconds to burn through the plastic-bonded plywood. And once the flame of the torch was removed the fire immediately died out. Even plain plywood, uncoated by resin, resisted the blow torch test better by several seconds than did the metal sheets, although it continued to burn after the torch was removed, unlike the plastic coated material.

Moreover, when the plywood is lined with asbestos, as is done on the inner surfaces of the engine cowling, the time required by the acetylene torch to cut through was a little over a half minute, more than *15 times* the length of time needed to burn through the stainless steel firewalls which the builders are required to install in their plane "for protection."

In addition to this, aluminum alloy metal, when subjected to the high temperatures engendered by gasoline fires, will abruptly melt and thus afford absolutely no support to the structure. Consequently, the part will collapse. The plastic bonded plywood structure, however, will retain its rigidity until it is burned completely through.

As the various structures of the Langley airplane are all formed on molds, which will produce the same structure identically time and again, there is no need for making extensive drawings. In fact, except for the drawings required to build the master molds, no drawings other than for engine mounts and landing gear are needed until a new and different design is wanted. Needless to say, great savings in time and money result not only from not having to make more than a few drawings, but also because all the parts making up the Langley airplane are interchangeable with similar structures in every plane built from the same molds.

The new molded plastic bonded plywood may also find application in building seaplane floats, flying boat hulls, gasoline tanks, etc., and is adaptable for military transports, gliders and large commercial airplanes. Any number of veneer laminations may be built up for the desired strength, the structures being much stronger for equal weight than comparable aluminum alloy structures now in use. Aerodynamic advantages are also claimed by virtue of the integral skin structure holding its true airfoil shape in flight with corresponding increases in the performance of the plane.

Performance and specification figures for the present Langley aircraft, powered by two 65 hp. Franklin aircooled engines, are as follows:

Span	35 ft.
Length	20 ft. 6 in.
Height	7 ft. 1 in.
Tread	10 ft.
Gross weight	2300 lb.
Weight empty	1410 lb.
Maximum speed	142 m.p.h.
Cruising speed	125 m.p.h.
Rate of climb (full load)	644 ft./min.
Service ceiling	15,000 ft.
Landing speed	46 m.p.h.
Range	600 miles
Fuel capacity	40 gal.
Fuel consumption	8 gal. per hr.

After the loading test on the Langley tail structure, in which 1800 lb. of sand were loaded on the horizontal stabilizer, there was no "set" or bend to the structure which returned to its original shape upon removal of the weights.

Now Available!

TO THE AIRCRAFT INDUSTRY

OUTSTANDING DEVELOPMENT GREATLY REDUCES CABLE STRETCH AND TENSION VARIATIONS

Cable stretch and tightening or slackening of cables due to variations in temperature are two problems that have become increasingly difficult with the use of longer and larger control cords. Now comes a logical and far-reaching development that offers radical improvements — Roebling Lock-Clad*— in which all straight sections of a flexible steel control cable are encased in dural.

In Lock-Clad*, cable stretch can be reduced as much as 80%, and temperature coefficient approaches that of the plane itself. Lower rigging loads are possible and greater sensitivity of controls is provided under all flying conditions.

Investigate this important step forward in aircraft control. Write for further information on the characteristics of Roebling Lock-Clad* and details on how it can be used in both new and existing planes.

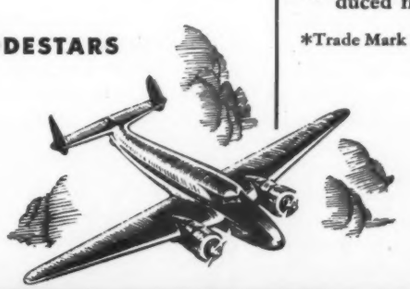
CHECK THESE FEATURES OF ROEBLING Lock-Clad*

1. Less Stretch in the Control Cables.
2. Smoother operation through the fairleads.
3. Less Variation in Tension due to temperature changes.
4. Better Pilot "Feel" due to reduced friction and spring effect.

*Trade Mark Registered U.S. Patent Office

NOW IN SERVICE—ON *Lockheed* LODESTARS

In utilizing Lock-Clad* cable for Lockheed Lodestars, the only change necessary in the original control system was widening the grooves of the fairlead pulleys. After several thousand hours of service in the elevator and rudder control systems, only normal wear is reported on the bare sections of cable where they pass over pulleys—with vastly improved pilot control under all operating conditions.



ROEBLING 1841 1941 100th ANNIVERSARY

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Selig Altschul

(*Continued from page 99*)

fear of post-war adjustments to the industry receives attention in virtually every discussion on the industry.

Investment trust selling of aircraft stocks, noticeable in the first half of 1941, became quite pronounced during the third quarter. One major trust alone, in this recent period, disposed of 12,600 shares of aircraft equities with an indicated aggregate value of more than $420,000. This trend shows no sign of abating—if anything these sales will probably be made at an increasing tempo.

While affected in a general way by the same factors that broadly influence the aircraft and other groups, the air transport industry finds itself in a highly favorable position. The air lines will be required to pay higher normal and surtax taxes. In no case, however, will such taxes exceed 31 percent of the corporate income. Once again, the air transport group is exempt from the payment of any excess profits taxes. Retained in the 1941 tax law, is the provision that air mail carriers are exempt from excess profits taxes, if earnings are less than the sum of the regular average earnings or invested capital exemption plus their total air mail revenues.

This favored treatment to the air lines is of prime importance and may endow the group with certain investment characteristics never before available. In a market that is highly tax sensitive, those issues which are so situated in that they avoid burdensome imposts, are likely to come to the forefront as a ready favorite.

It is difficult, however, to ascribe the recent strength in air line issues solely to the tax factor. In the post-war period, this group stands to be one of the leading beneficiaries of our present aviation development. Moreover, the long secular growth trend is a major uplifting influence.

Of immediate encouragement is the better earnings reports currently being released by the major lines. Temporarily overlooked are the ominous implications contained in the examiner's report on American Airline's mail rates. While lower mail compensation is anticipated, it is the retroactive feature of the examiner's report which can deal the industry a vital body blow. If the full CAB sustains the right to re-examine previous year's results in order to demand the return of alleged excessive revenues no air line is secure in retaining previous earnings. This whole problem will undoubtedly be clarified when the CAB issues its findings on the American Airline's examiner's report sometime this year.

Bolstered by heavy defense travel, all air lines are reporting improved results as contrasted to the disappointing returns revealed during the first half of 1941. This is a condition prevailing for most of the air carriers.

American Airlines for the first six months of 1941, failed to make an impressive showing, its profits amounting to $1.51 a share on its 575,000 shares of common stock as contrasted to $1.55 a share earned in the like period a year ago. In July, however, the company's earnings turned definitely for the better with an expansion of about 30 percent in gross being accompanied by a rise of more than 90 percent in net. Ordinarily, the company reaches its peak earnings in October. Estimates place the company's results for the final five months of the year at a much better level than for the corresponding period a year ago. On the premise, that the present trend will continue, American may be expected to show earnings of at least $4.00 a share for the full year compared to $3.13 for 1940.

BARRON'S STOCK AVERAGES

	Aircraft	Air Transport	50 Stocks
Oct. 3, 1941	37.35	22.41	72
Sept. 26, 1941	37.45	21.81	72
Sept. 19, 1941	39.22	22.94	74
Sept. 12, 1941	39.15	22.94	73
Oct. 4, 1940	38.10	27.91	76

Eastern Air Lines followed up its record-breaking second quarter with the biggest third quarter in its history. Generally, the summer months are the slack period in the company's operations. Nevertheless, results for the third quarter may almost equal the profits for the three months ended June 30, 1941. In previous years, the third quarter has always shown a major decline in earnings. With the background of results thus far, the company should show a net profit for the nine months to Sept. 30, 1941 of better than $1,000,000 or about $1.80 per share against $1.41 a share for the like 1940 period and only $1.08 in the initial nine months of 1939. For the full year 1941, the company may show net earnings of at least $3.00 per share on the basis of 572,178 shares outstanding. This would compare with $2.80 per share for 1940.

United Air Lines is also participating in the record-breaking traffic, with corresponding improvement in earnings. For the first half of 1941, the company was still in the red to the staggering extent of $562,316. This represented a material improvement over the deficit of more than one million dollars for the first quarter. A net profit for the three months ending Sept. 30, 1941 is indicated of at least $1,400,000; equal to 93 cents a share. This recent quarter finally placed the company in the black with the expectation that the company may end the year in the profit column. It is likely, however, that United may not equal 1940 results when 52 cents per share on 1,500,451 shares was reported.

The major units in the air transport industry have clearly demonstrated that they possess tangible earning power despite the various restrictions placed in their path. If the group can do as well as it has under the adverse conditions prevailing this year, it takes little imagination as to what the industry can do if given a more favorable combination of developments.

The forced-draft research in airplane construction and design, engines, propellers and equipment made necessary by the war, will all be made available to commercial aviation. Not only will bigger and faster airplanes result, but equipment will be conducive to greater safety in the air.

Probably the most important element will be substantial reduction in operating costs which will broaden the horizon of the air line markets.

All sorts of predictions have been made as to the type of luxury equipment to be flown in the future. These planes range in projection from the ultra-luxurious non-stop airplane, the Twentieth Century Limited of the skyways to the special-built cargo planes for freight and mail.

It is this combination of favorable circumstances surrounding the air lines —their present tax status, current earnings, secular growth and future potentialities—that has given the group an aura of investment respectability and the signs accumulate that astute investors are in the process of increasing their commitments in the industry.

Window Shopping

Rivet Bucking Bars—Complete catalog has been issued covering more than 100 different types. Aeroloy bucking bars are of special steel developed to meet exacting requirements of heavy duty riveting. Aircraft Tools, Inc., Los Angeles, Calif.

The Blue Knight—Maybe you'll be interested to know that all that's between you and a nasty forced landing is a coat of lacquer 10 mils thick; and if the coatings on your ignition cables are shot, you may get a demonstration of what we mean. Vol. 1, Sept., 1941, No. 5. Roxalin Flexible Lacquer Co., Inc., Elizabeth, N. J.

Aqua Flotation System—Stop evaporation of volatile aviation fuels, and avoid a frown from Mr. Ickes. The Aqua airport fueling pit is a "closed" system, no air space in the tank. Tank is automatically kept filled; explosion and fire hazards said to be eliminated—completely sealed underground, fire cannot reach the tank. Pit box, controls, as well as tanks, can be completely submerged in water and still be operative. Faster handling of planes made possible by more rapid fueling. Aqua Systems, Inc., 385 Gerard Ave., New York, N. Y.

A NEW *and* EFFICIENT SUPPORT *for the* VITAL VOICES *of the* AIR . .

It has been the privilege of the Continental-Diamond Fibre Company to work with the Glenn L. Martin Company in developing...now in mass production... a DILECTO MOULDED LAMINATED PLASTIC RADIO ANTENNA MAST.

The final result not only answered what had been considered the prime requisite... but, also possessed other characteristics which proved of considerable value. The tapered design of the C-D DILECTO mast provides higher structural efficiency . . . better appearance . . . and this modern design is an engineering achievement presenting no manufacturing difficulties such as would be met in light alloy metals.

A few months from the time the Glenn L. Martin Company first made their request... C-D had a suitable mast ready... for C-D has more than 30 years' experience in phenolic plastics.

Perhaps C-D's accumulated wealth of "Know HOW" in Fibre... Laminated and Moulded Plastics ... and other NON-Metallics may be helpful in solving your "What Material" problems.

Get in touch with C-D, #14 Chapel Street, Newark, Delaware.

Continental-Diamond FIBRE COMPANY

"Manufacturers of Laminated Plastics Since 1911"

NEWARK • DELAWARE

Canadian Training

(*Continued from page 57*)

North American Harvard, or Fleet Fort. Graduation comes with the ceremony of receiving wings, sergeant's stripes, or commission as Pilot Officer (one-third at graduation, 17 percent overseas) depending on examination rating.

Air observers and bombers after their stint at the initial training schools go for 14 weeks to one of ten air observer schools to learn navigation, photography, reconnaisance, flying in Avro Ansons, Cessna Cranes, Fairey Battles or Noorduyn Norsemans. They also study mathematics, wireless, meteorology. Then come six weeks at one of 10 bombing and gunnery schools, where they learn to drop bombs on targets, study bombsights, wind-drift, to plot course. A final 4 weeks are put in at 2 air navigation schools for advanced navigation instruction. Graduation brings a half wing with letter O for observer, sergeant's stripes or if one of lucky third, a commission.

Wireless operator-gunner spends his first 20 weeks after the 2 weeks at the manning depot at one of 4 wireless schools, where he learns the ins and outs of modern aircraft radio communication, both in the air and on the ground. With him are studying ground radio operators and radio mechanics. He also learns to know the armament of the planes he is to fly, and when he passes the examinations at the wireless school puts in 4 weeks at the 10 bombing and gunnery schools learning to shoot moving model planes and in the air to turn his gun on real life size targets. Graduation brings him a half wing with letters AG for air gunner, sergeant's stripes, or if one of the top 20 percent of the class the rank of Pilot Officer.

Following graduation, a certain number of the men are turned into instructors, others receive operational training with the air force commands on the Atlantic or Pacific coasts, the balance go overseas to train.

Practically all the airplanes used for the elementary and intermediate training are now made in Canada. The Dominion will be using 4,000 planes by the end of 1941, according to plans made early in the year. Thirteen different types of planes are now made in Canada, a number which is to be cut in half to increase production and eliminate some now obsolete types. According to Ralph Bell, director general of aircraft production for Canada, the Dominion will shortly confine itself to building for the Empire air forces one elementary trainer, one single engined advance trainer, one twin engined advanced trainer, one coastal reconnaisance amphibian, one bomber and one fighter.

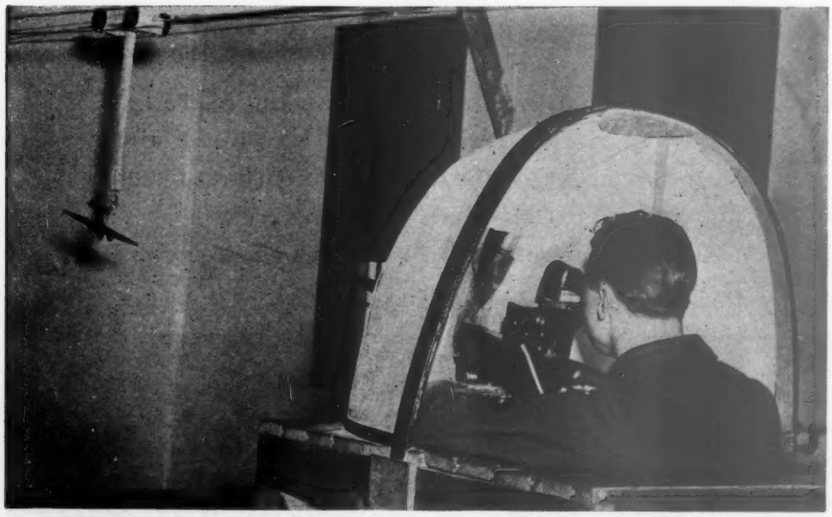
Establishing training schools and airfields has been a tremendous task which had to go ahead at the same time that actual flying training, ground and administrative training was carried on at maximum efficiency. In many out-of-the-way places training schools have been built and airfields laid out from virgin bush or farmland. Elsewhere provincial and municipal institutions have been turned over to the air force and equipped for use as initial training schools, wireless schools, ground schools, etc. In recent months has come the additional job of finding facilities and equipment for the training of the Canadian Women's Auxiliary Air Force.

Wireless air gunners learning radio compass work at one of four schools for such work.

The Royal Canadian Air Force does not lack for recruits, and to build up a trained reserve the Air Cadet League has been set up to train high school boys in the rudiments of aeronautics, navigation, signalling, aero mechanics, aero engines, and air force drill, as an after school course destined to cut down air force training by several weeks when the boys become old enough to join the air force. The Air Cadets started operations on a national scale with the start of the current school year. Meanwhile Canadian schoolboys have contributed to the Commonwealth Air Training Plan by building exact scale models of all types of British, American, German and Italian planes used, the work being done by the boys at Ottawa Technical School. The models are used by the air force for a variety of purposes including type recognition, to point out vulnerable spots in enemy planes, for use as moving models on indoor gunnery ranges, for use in showing flight formations.

Universities have during the summer given special radio courses to air force trainees, and during the present university year will enable students desiring to join the Royal Canadian Air Force as air crew to take the five week initial training school work during the academic year with a two week training camp at an air force station to follow next summer. The course calls for 200 hours of instruction.

The Commonwealth Air Training Plan is now functioning smoothly, a vast organization set into operation less than two years ago. From now on it will turn out the maximum number of airmen for which it was set up, estimated to be 25,000 a year.



At the gunnery school, wireless air gunners who have passed the radio course spend hours estimating the range of moving model Messerschmitts.

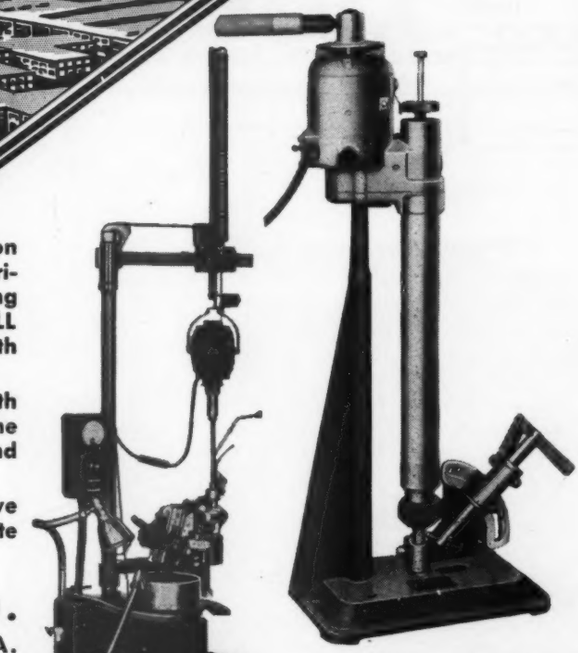
HALL KEEPS PACE WITH THE AIRCRAFT INDUSTRY

Because airplane engine manufacturers use them for production and army and navy air depots, transport companies and privately owned shops all over the world use them for restoring original factory precision and finish, production of HALL ECCENTRIC Valve Seat Grinders has naturally grown with plane production.

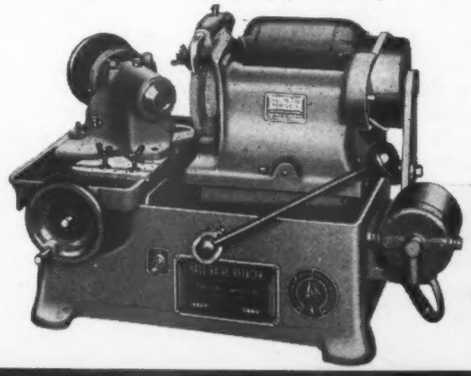
In development, too, HALL engineering has kept pace with aviation engineering. That's the one reason why airplane engine performance has been improved, valve life multiplied and production and overhaul speeded up.

HALL builds or CAN build ECCENTRIC type precision valve seat grinders to meet YOUR requirement. Catalog and complete information await your request.

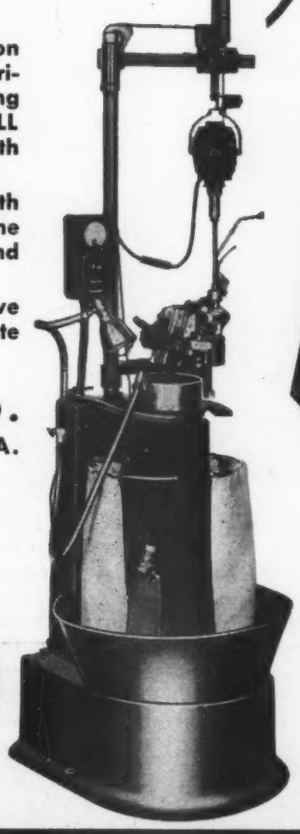
THE HALL MANUFACTURING CO.
1634 WOODLAND AVE. TOLEDO, OHIO, U. S. A.



MODEL EJA Grinder (above) is designed for service and limited production use where valve seats are located deep in in-line cylinders.



Right: **HALL WET TYPE Aero Valve Refacer with dual motors, rheostat control and a patented chuck that won't brinnell the valve stem. Wet grinding prevents head distortion and surface burning.**



The HALL Model AW (*left*) is a WET TYPE ECCENTRIC Valve Seat Grinder made in production and service types. Adopted by engine builders, army and navy air depots and maintenance shops all over the world.

HALL ECCENTRIC SEAT GRINDERS

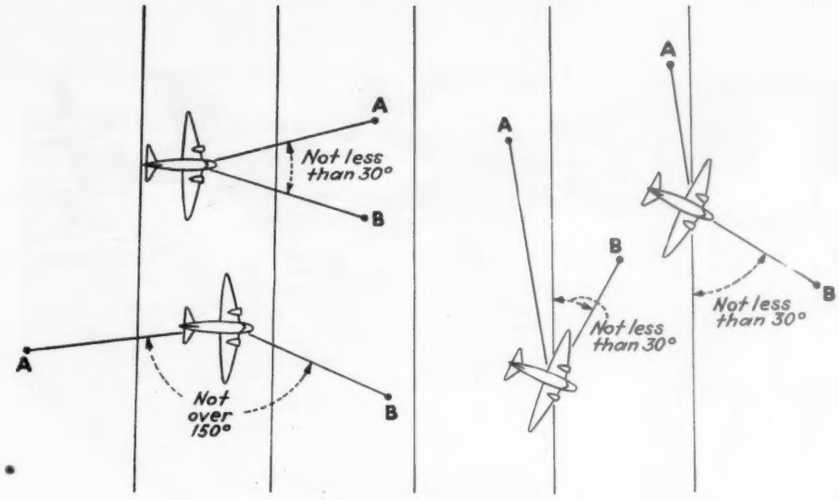


Fig. 5 Suitable Bearing Angles

Radio D/F Bearing Log

Date_____ Trip_____ Crew_____ Nc_____

D.R. Position	Mag Heading	No.1 Bearing and Time	No.2 Bearing	No.3 Bearing and Time	Time of Fix	Plotted Position	Remarks

Fig. 6

(*D/F article cont'd from page 73*)
thought to the problem. Invariably, the amateur at the job will just decide to take bearings and with no further preparation, start in. Inevitably, the result is confusion, wasted time taking bearings, and a fix of dubious accuracy.

The accuracy of any position fix by means of radio bearings is almost equally dependent upon the skill with which the bearings are taken and the skill with which they are translated into a fix by plotting on the map. For the moment discussion will be limited to actually taking the bearings.

Several factors enter into this operation to influence the resultant usefulness of the bearings in plotting the fix. These should be considered prior to actually taking the bearings and the plan of operation formulated mentally so that the actual operation of using the direction finder may be performed rapidly.

First, it should be realized that a fix is dependent upon the intersection of two or more lines of bearing on different radio stations. With this in mind, it should be apparent that the two lines of bearing should not intersect at relatively small angles since a minor inaccuracy in one of the two bearings will result in a major displacement of the intersection. Usually it is not considered wise to take bearings on stations which will produce less than a 30 deg. or greater than a 150 deg. angle between the intersecting lines of bearing. In addition, when using only two bearings, the angle between one line of position and the meridian should be not less than 30 or greater than 150 deg. This is shown diagrammatically in Fig. 5.

While the selection of stations giving desirable angles of intersection to the lines of bearing is an important consideration, other factors also exist to influence the selection. The more distant the station, the wider the null is likely to be, and therefore, the greater possibility of bearing error exists. When possible, select stations within 150 miles which promise a relatively good null in preference to low-powered or distant stations. On the other hand, stations at less than 25 miles distance are not always favorable due to the rapid angular change in bearing caused by the airplane's movement. This effect is minimized, of course, if the station bearing lies within a few degrees of the nose or tail of the airplane.

Having mentally selected the desired station, it is often wise to tune each of them in on the regular receiving antenna as a check prior to taking bearings. It is a good plan at this point to write down the identification letters and frequency of each station to be used. While some type of D/F printed log sheet is unquestionably a help if position fixes by bearings are a regular routine, it is probable that the average pilot will not be so provided. Refer to Fig. 6. In this event he should not trust too much to his memory but should note down all necessary information for quick reference, and especially while taking the bearings, should not fail to write each down as taken.

The final item to decide is the order in which the bearings will be taken. Unless otherwise desirable, the fastest procedure is to take the bearings in order of the station frequency. This eliminates unnecessary cranking of the tuning controls. Sometimes, however, when a station is both fairly close and broadside to the airplane's direction of motion it is best to take this bearing as the second of three bearings so that it will coincide approximately with the mean time of the three.

From the time taken to outline these factors which must be considered before taking the bearings, it might appear that it is necessary to deliberate at great length each time it is desired to take a fix. In practice, just the reverse is true. Usually, if the approximate position of the airplane is known from dead reckoning, a very brief inspection of the map will immediately suggest desirable stations to use. Checking their reception prior to actually using the direction finder is not always necessary; yet, whenever any doubt exists that the desired stations may be picked up, it is a sensible precaution. In other words, what is being recommended, is that everything possible be done prior to actually taking bearings to insure that they will be *accurate* and *useful*. The more of these items which can be decided upon ahead of time, the less time will be needed with the direction finder. This is an important consideration since the longer the time needed to take bearings, the greater will be the error in the fix caused by the airplane's movement.

Technique With Direction Finder

Provided proper thought has been given to the problem beforehand, the actual operation of taking sufficient bearings for a fix is a relatively simple matter. The two most important points in taking the bearings are to obtain as accurate a null as possible on each station, and secondly, to complete the whole operation without waste of time. With practice, it should be possible to obtain three bearings within a total elapsed time of two minutes.

Since the operation of taking three bearings on three different stations may be considered the most difficult case met in practice, a suggested technique for accomplishing this rapidly is as follows:

1. Note and write down the magnetic heading of the airplane. Hold this as accurately as possible while taking the bearings.

2. Tune in the station on which the first bearing is to be taken. This may be done using the standard antenna—or, if the approximate direction to the station is known, on the loop. If the station is tuned in on the loop, care must be exercised that the maximum

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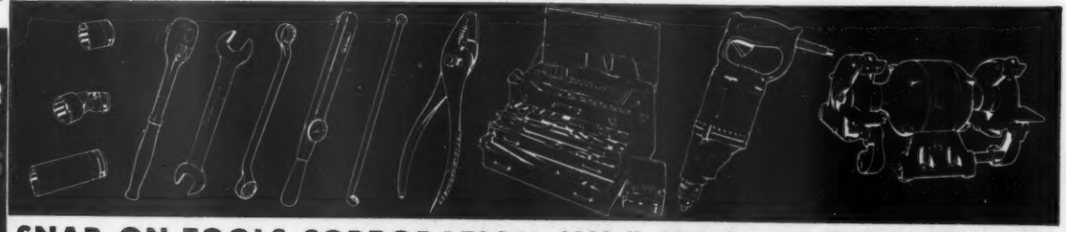

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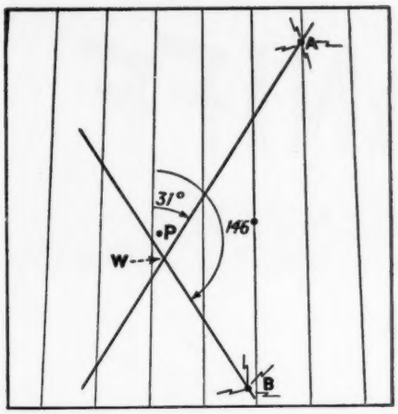

Fig. 7 Plotting With Observed Bearing

position of the loop is pointed in the general direction of the station so that the signal will be heard. Make station identification positive by waiting for the identification signals.

3. Using as high a volume level as practical, obtain a null bearing on a station. Write this down and the time of obtaining it.

4. Tune in the second station as was done for the first. Make identification positive and obtain the null. Write the bearing down. (The time does not need to be taken.)

5. Repeat as above for third station and note the time third bearing was obtained.

6. Using the time of the first and third bearings, mentally calculate the mean time. This will be used as the time of the fix.

In actual practice, it is not always easy to decide exactly where the null comes on the azimuth dial. As explained in a previous article, the higher the signal level the narrower will this zone of null be. Nevertheless, it is seldom a definite point. To obtain a dial reading that will be used as the bearing, the loop should be slowly rotated through the null zone and the two readings at which the signal becomes audible, noted. Taking the mid-point between these usually gives an accurate bearing.

Frequently, the atmospheric noise level prohibits the use of a high volume. If so, a wide null may be split in the manner just explained. It will be accurate as long as the two readings defining the width of the null are carefully obtained.

A common fault often observed with beginners in taking bearings is that too much time is wasted in trying to decide the exact location of the null. While precision is an asset, probably it will not be gained by indecisive rotation back and forth through the null. One or two trials at most should be sufficient.

Any bearings taken which are considered of doubtful value should be noted as such. While a pilot in flight can remember this if he is plotting it himself, it is necessary that the man on the ground be definitely advised of doubtful bearings if the position is to be plotted by ground personnel.

Plotting of Fix

As previously explained, a position fix by D/F bearings is determined by the intersection of two or more radio lines of bearing. Since a fix represents a definite geographical position over the earth's surface, it is always determined by some method of graphical plotting on a chart representing the proper area of the earth.

All methods of plotting are directed toward the same goal—find the spot where the given lines of bearing intersect. One very simple system of plotting bearings is to convert each relative bearing as read from the azimuth scale, to a true bearing and draw these as lines of position on any suitable chart. Refer to Fig. 7.

A pilot flying in the vicinity of point P determines the relative bearing of station A as 306 deg. and the relative bearing of station B as 60 deg. The magnetic hearing at the time is 90 deg. Variation 5 deg. west.

First, the true heading is found to be 85 deg. (90–5). The true bearing on station A is 31 deg. (85 + 306 — 360), and on station B is 146 deg. (85 + 60).

He is uncertain of his position but assumes he is near the point P. The true bearing of station A is plotted on the chart at the meridian nearest the assumed position by moving the protractor along the meridian until the line of bearing passes through the radio station. In similar fashion, the line of bearing to station B is plotted. The intersection of the two lines of bearing gives the fix at W.

A variation of this method of plotting a fix makes use of special radio direction finding charts printed by the U. S. Coast and Geodetic Survey office. These, like the sectional and regional aeronautical charts, are constructed on the Lambert projection at a scale of one to two million. See Fig. 8.

Around each radio range station is printed a special compass rose oriented to magnetic north instead of true north. These compass roses are intended primarily to allow plotting the lines of bearing *from the radio station* rather than at the meridian nearest the assumed position as above. To do this with an ordinary map, the geographical bearings as taken at the airplane must be converted arithmetically to reciprocals (add or subtract 180 deg.). On these D/F maps the outer figures of the compass rose provide this conversion to reciprocals directly, thus saving time and eliminating errors in arithmetic. The following example will illustrate the use of these charts.

The pilot takes three relative bearings as follows: Cincinnati 280 deg.; Goshen 350 deg.; and Detroit 70 deg. The magnetic heading is 280 deg.; variation is 3 deg. west.

Since the compass roses on the map represent magnetic directions, the relative bearings need only be converted to magnetic rather than true bearings. These are Cincinnati 200 deg. (280 + 280 — 360); Goshen 270 deg. (280 + 350 — 360); and Detroit 350 deg. (280 + 70).

To plot, refer to Fig. 8. Using the above magnetic bearings and the outer numbers on the compass rose at each station, construct three lines of bearing as shown. These three lines of bearing do not intersect at one common point, but form a small triangle. This is due to the movement of the airplane while the bearings are being taken. If this triangle appears overly large, the most probable position of the airplane is at the center of the triangle.

The method of plotting described with these special charts can be considered the most practical. A small amount of error is introduced, however, by not allowing for the convergence of meridians and the difference between the magnetic variation at the radio station and the variation at the airplane. If extreme accuracy is desired, these must be considered. This is explained on the chart itself.

Three-arm Protractor Position Plotting

The chief fault of the two methods of plotting positions which have just been described is that they are difficult to perform in the cockpit of the average airplane. For plotting positions in the cockpit, a special three-arm protractor of the type shown by Fig. 3 is recommended. (See Part I of this article, July 1941.) American Airlines has developed this for use in conjunction with a special direction finding strip map. The mileage scales stamped on the arms of the protractor match the scale of the charts (1 inch—24 miles). A separate chart is made up to cover each section of the country flown by this company. Also to facilitate use in the cockpit the charts are mounted on a special plotting board which allows the portions of the map not being used to be rolled out of the way.

The use of the three-arm protractor is extremely simple. Fig. 3 shows this instrument as set to duplicate the plotting of the same fix shown in Fig. 8. To set up any problem on this protractor, it is only necessary to realize that the base plate, A, when properly oriented on a chart, represents a com-

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pass rose. The rotatable azimuth scale, B, with the sketch of the little airplane corresponds to the loop azimuth scale and each arm can be set to represent one bearing on the rotatable scale, B, it will read as a relative bearing; and on the base plate, A, it will read as a true bearing provided the zero of scale B (corresponding to the nose of the airplane) is rotated to show the true heading being flown.

To illustrate more fully how three bearings are set up and plotted with this protractor, the same three bearings as used in Fig. 8 will be used.

Three relative bearings are taken as follows: on station A, Cincinnati, 280 deg.; on station B, Goshen, 350 deg.; and on station C, Detroit, 70 deg. The magnetic heading is 280. Knowing the approximate location of the airplane, the pilot obtains from the chart a variation of 3 deg. west. With this, the true heading of 277 deg. is obtained (280–3). The zero of scale B is set opposite 277 of scale A to represent the airplane's true heading. One arm is set on scale B to 280 deg. representing the relative bearing of 280 deg. on Cincinnati. In like fashion the other two arms are set on scale B to represent the relative bearings on Goshen and Detroit.

Having set the protractor, it is placed on the chart so that the base plate is properly lined up with the meridians and each arm falls over the proper station. A dot made by inserting a sharp pencil through the hole in the center of the protractor denotes the fix.

Frequently it is not possible to line up all three arms over their respective stations while maintaining the base plate truly aligned with the meridians. Minor errors in the bearings, airplane movement while the bearings are being taken, or compass error may all contribute to this. Only experience in taking and plotting bearings will assist one to properly evaluate the effect of each of these.

Sometimes when a fix becomes doubtful due to an overly large accumulation of such errors it is a help to plot the position using successively different pairs of the three bearings plus the heading. In this way each plot will produce the fix at a slightly different location. The three locations arrived at thus form a triangle, as happened in Fig. 8. This is usually termed the triangle of error. The most probable position is at the center and this is used as the fix.

As was mentioned previously, the three arm protractor allows a fix to be plotted with only three relative bearings and no heading. When the heading is unknown due to compass failure, or it is suspected that compass error is responsible to fixes of doubtful accuracy, this method should be tried. All that is done is to set up the three relative bearings on scale B of the protractor as was previously explained. Without considering the position of the base plate in relation to the meridians, place the protractor on the chart so that the three arms fall over their proper stations.

Plotting without using a heading is recommended only in an emergency or to check for possible compass error when a fix plotted with the heading does not work out satisfactorily. Without using the heading it is possible to fall into a situation where the position is indeterminate. This happens when the position of the airplane and all three stations are located approximately on the circumference of the same circle. This is known as a "revolver."

The advantages of plotting positions with the three-arm protractor should be apparent. In the first place when combined with a proper plotting board it is very much easier to use in the cockpit than other methods. Secondly it makes the drawing of actual lines of position unnecessary and thus keeps the chart free of pencil marks. Very much more important, however, is that this device allows the plotting of positions with relative bearings. The protractor itself performs all the needed conversions to true or magnetic bearings. Once the method of setting up the bearings is understood the whole process of plotting fixes is made more rapid and positive than other methods

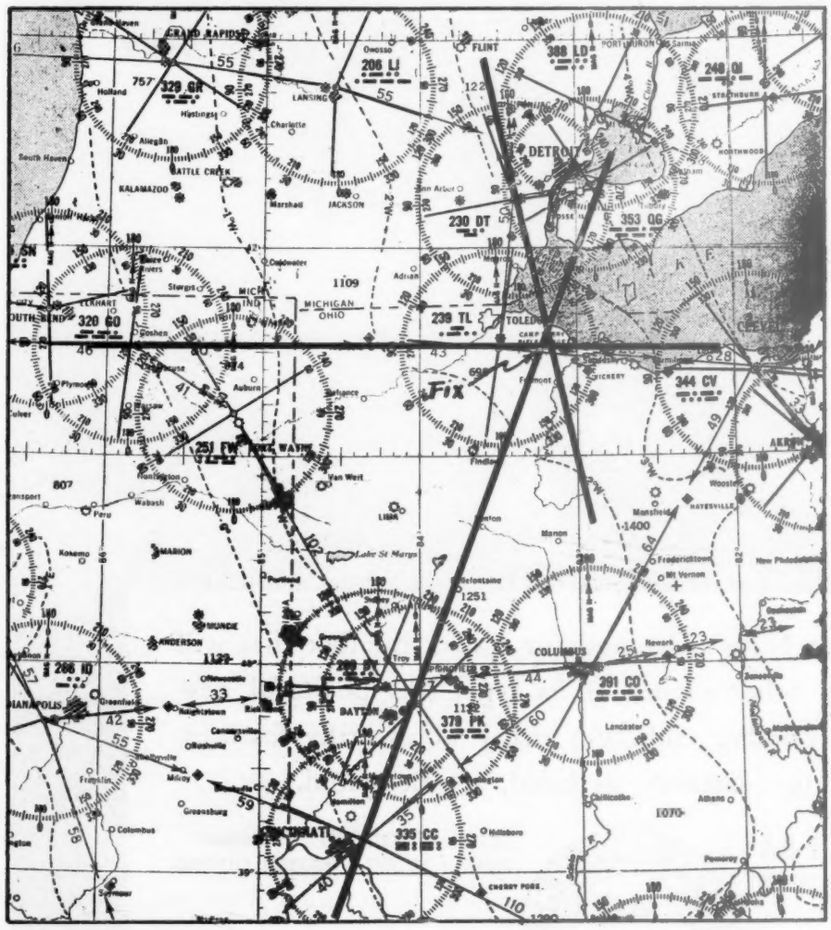

Fig. 8

To facilitate the plotting of radio bearings there is printed around each radio range station a special compass rose oriented to the magnetic meridian instead of the true meridian. To plot a radio bearing it is only necessary to draw a line from the range station through the corresponding graduation of the compass rose, using the OUTER (larger) figures. The line so drawn is the desired-line of position. The outer row of figures eliminates the necessity of applying 180° to obtain a reciprocal bearing.

For utmost accuracy corrections may be applied for the convergence of the meridians and for the difference in the magnetic variation at the airplane and at the radio station. The correction for convergence of the meridians is 0.6° for each degree of longitude. If the airplane is west of the radio station, add the correction; if the airplane is east, subtract. The difference between the magnetic variation at the airplane and at the radio station should be added if the variation at the airplane is smaller westerly or greater easterly than at the radio station; subtracted if the reverse. In the majority of cases, this correction will be of like sign to the correction for convergence.

The INNER (smaller) figures of each compass rose are provided for those who desire a compass rose reading from magnetic north.

In a few cases compass roses have been omitted to avoid congestion. Bearings toward these stations may be plotted as follows: at the meridian nearest the position of the plane lay off the observed bearing with a protractor; a line from the radio station parallel to this plotted bearing is the desired line of position.

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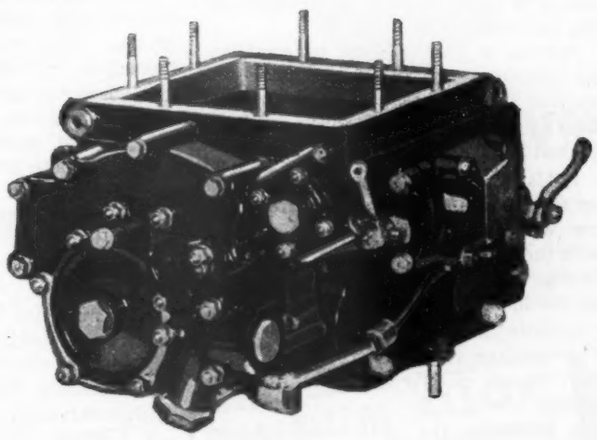

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which require arithmetical conversion from relative to magnetic or true bearings and computation of reciprocals.

Running Fix

A running fix is obtained by taking bearings on either the same or different stations with a time interval elapsing between the bearings.

When two different stations are used the running fix differs very little from the instantaneous fix other than allowance must be made for the movement of the airplane during the time between the first and second bearing. If the time interval is three minutes or less the mean time is used for plotting both bearings and thus an instantaneous fix is achieved. Only when the time interval between bearings becomes of sufficient importance to appreciably affect the accuracy of the fix is the running fix resorted to with two bearings. First the line of position obtained from the first bearing is plotted for the time it was taken. It is then advanced in a direction and distance corresponding to the assumed movement of the airplane during the time interval to the second bearing. The intersection of the second bearing's line of position with the first carried forward becomes the fix.

Another type of running fix is possible by taking successive bearings on one station. Referring to Fig. 9, one of the several variations of this method is shown. For those mathematically inclined, it will be apparent that a solution of a right triangle is the basis of this particular procedure.

Assume a pilot desires to establish the direction and distance from his position to a station which lies to one side of the course being flown. The method is as follows:

1. Using the *track* being made good, set the loop null position so that a bearing will be obtained on the station with the pointer at 90 deg. to the track. In Fig. 9 the pointer will be set to 280 on the loop azimuth scale.

2. Note the time the null is received. The airplane is then at position A in Fig. 9, or exactly broadside to the station.

3. Maintain the same heading and track for two, three, or five minutes.

4. At the end of whatever time interval selected, rotate the loop to obtain the new bearing. Note the number of degrees of null change this is from position A.

5. Calculate the distance flown during the time between the first and second bearing (positions A and B). This is easily done on any calculator by using the assumed groundspeed and the time flown. This figure becomes the length of side AB of the triangle.

6. The angular change in bearing between position A and B is the same angle as angle ASB of the right triangle. Using this angle and the length of the side AB just calculated either or both sides AS or BS can be found. This operation is also easily done on any navigational computor by simply solving for a right triangle.

7. Side AS becomes the distance at which the station is passed broadside and BS the distance to the station at the completion of the run.

8. After converting the second bearing obtained to a true bearing, a line of position from B to the station may be plotted. The calculated distance BS completes the fix.

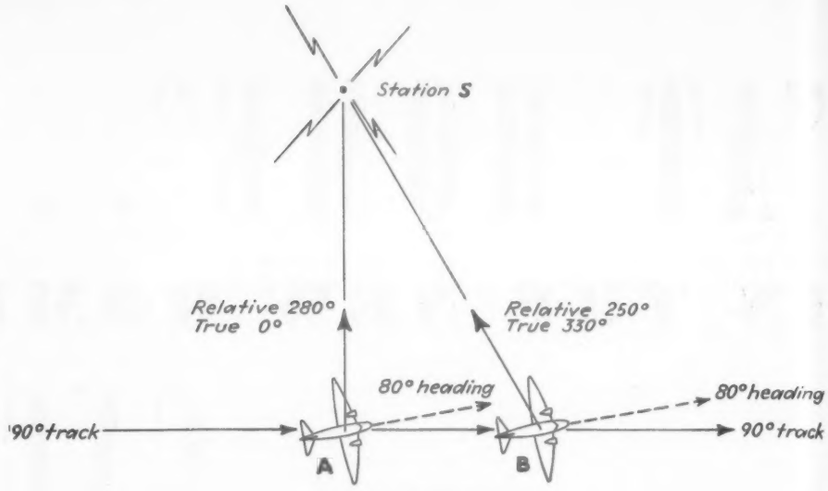

Fig. 9 Running Fix

As shown by Fig. 9, a typical problem of this type might work out as follows:

The magnetic heading is 80 deg. while making good an assumed track of 90 deg. The assumed groundspeed is 120 m.p.h. Setting the loop to obtain a null when the airplane is due south of the station gives a relative bearing of 280 deg. at point A. Three minutes later at B the relative bearing is 250 deg. Solution:

1. Three minutes at 120 m.p.h. makes side AB 6 miles.

2. Angle ASB is 30 deg. (280—250).

3. Solving for the unknown sides of the triangle with a computor (or any other means desired) gives side AS as approximately 10.5 miles and side BS as approximately 12 miles.

4. Convert the relative bearing of 250 deg. to a magnetic bearing of 330 deg. This allows the line of bearing SB to be plotted on the chart. Scaling off the calculated distance SB 912 miles completes the fix.

While the above method of obtaining a running fix is only one of several similar procedures, it may be considered representative of the general idea. All are based upon finding the angular change of bearing which takes place on one station while passing it on a steady heading and speed. Likewise, in all cases the solutions are based upon the solution of some type of triangle.

The primary advantage of all such procedures as that just described is that reception on only one station is needed to obtain a fix. The particular method selected for explanation also offers a very simple and practical means of determining *distance* from a station. It will be apparent that this procedure can be effectively used in conjunction with a loop orientation of the pointer progression type.

The obvious disadvantage of such procedures is the probable errors that are introduced in the fix if the assumed groundspeed and track are inaccurate.

For anyone desiring additional procedures of this type reference is suggested to any modern text on marine navigation practice with the pelorus.

TWA Painting

(*Continued from page* 63)

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(*Continued from page 79*)

Stretch

Strictly accurate figures and curves showing the stretch of aircraft cable under varying loads were not considered essential until recent months and, consequently, few really accurate laboratory tests were made, and even fewer were made available to the aircraft industry.

It is, therefore, easily understandable why many aircraft engineers are not now thoroughly conversant with this subject at a time when the emphasis on increased plane speed and maneuverability requires an accurate knowledge of cable stretch characteristics. Recently very accurate stretch tests have been made, but their interpretation and application to specific problems require a general knowledge of types of cable stretch.

Cable stretch may be divided into two types, constructional stretch and elastic stretch.

Constructional stretch is due to the initial "seating" of the individual wires

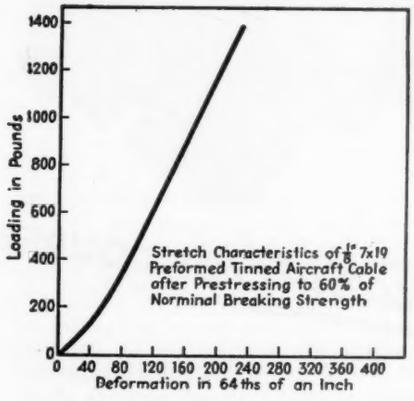


Fig. 7

and strands and is largely eliminated after the application of an original load. The general practice of pre-stressing cable immediately before installation is for the purpose of eliminating this constructional stretch, and this practice is required by Army and Navy Specifications which call for an applied load of 60 percent of the cable breaking strength maintained for a minimum period of three minutes and then installation without subsequent recoiling.

It is very important, if the full benefit of pre-stretching is to be realized, that cables be installed immediately after this operation with a minimum of handling and flexing. The practice of pre-stretching cables with very precise apparatus for accurately controlled periods of time and then tossing the cables to the ground where they assume coiled positions and are kicked around for hours before being installed, eliminates practically the entire effect of pre-stretching. Likewise, the practice of pre-stretching, then subsequent coiling and carrying by only one man, eliminates much of the effect of pre-stretching.

Numerous laboratory tests have shown that approximately 75 percent of the initial constructional stretch in a cable is returned to the cable once it has been loosely coiled after pre-stretching. Therefore, if constructional stretch is not to be a factor after installation, reasonable care must be exercised to reduce cable handling and flexing to an absolute minimum between the time of pre-stretching and the time of installation.

Elastic stretch is due to the inherent property of the steel wires to stretch under load. This type of stretch which, of course, cannot be measured independently of the small residual constructional stretch always present after pre-stretching, is shown in Fig. 7 plotted against load for $\frac{1}{8}$ in. cable. In general, the modulus of elasticity of tinned aircraft cable runs between 18,000,000 and 23,000,000 p.s.i. for all sizes of cable from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. inclusive. In other words, a 30 ft. length of $\frac{1}{8}$ in. diameter 7x19 Preformed tinned aircraft cable, after proper pre-stretching and subsequent loading to 20 percent of its breaking strength, will stretch .92 in. This stretch must be allowed for when control surface deflections and stick loads and movements are being calculated. (For accurate empirical curves on cable stretch for all sizes of cable, write to the author in care of American Chain & Cable Company, 230 Park Avenue, New York City.)

Splices vs. Swaged Ends

It must also be recognized, when calculations are being made for cable stretch, that allowance must be made for the stretch in splices when cable end splices are used. The amount of stretch in splices is considerable. In fact, tests have shown that in an average cable assembly with thimble splices on each end, fully half of the stretch observed under normal loading was due to the seating of the tucks in the splice, and this was not entirely removed by pre-stretching.

Of course, use of the swaged type cable end, which replaces the splice, eliminates the necessity for estimating splice stretch, since the swaged type cable end does not stretch. It is for this reason, coupled with many others, that on all Army and Navy planes the swaged type cable end is used exclusively. It is also being used, or is fast replacing, the spliced end on other classes of planes.

The swaged type cable end, or Tru-Loc fitting as it is commonly called, (See Fig. 8) was developed by the American Chain & Cable Co. It is attached to cable by a patented swaging process which actually cold flows the

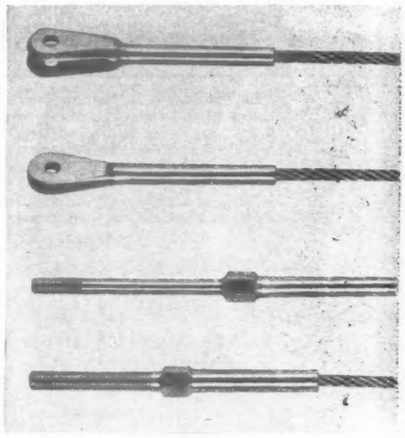


Fig. 8

metal in the shank of the fitting into the interstices of the cable. Thus, a 100 percent efficient bond is assured and slippage or stretch is prevented. A properly attached Tru-Loc fitting will definitely develop the full rated breaking strength of the cable to which it is attached. In fact, it is required by specifications to do so. This is to be compared with the thimble splice which C.A.A. rates as being only 85 percent efficient and which will stretch considerably under load. With its many other important attributes, such as its light weight, its small size, its precision design, its economy, etc., the Tru-Loc fitting certainly deserves the ever-increasing prestige it is gaining.

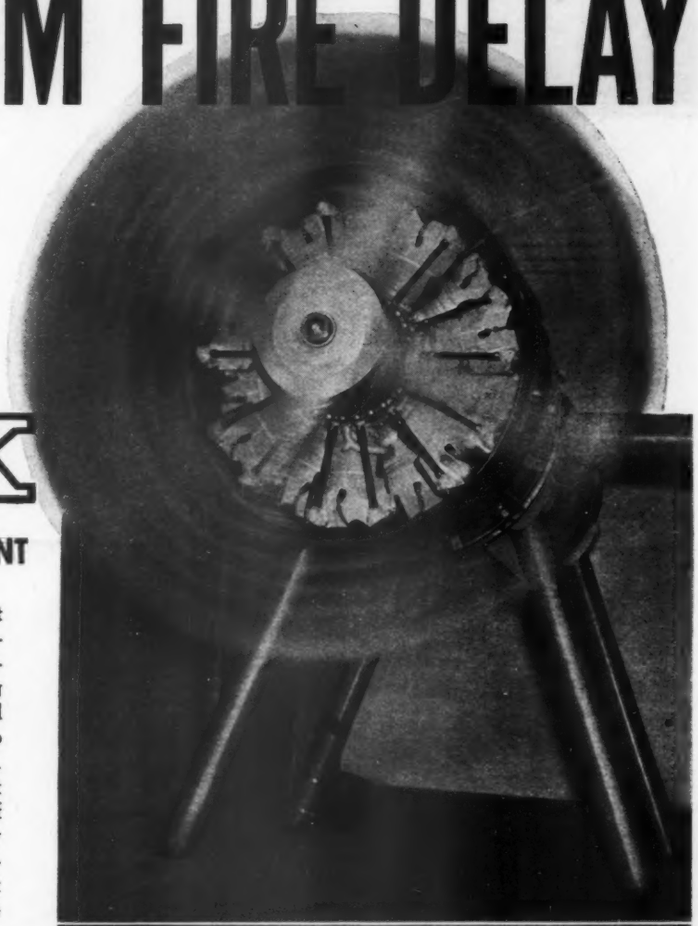
It is apparent from the above that the type of end connectors used on aircraft cable assemblies is equally as important as the proper application of the cable itself. Therefore, in designing cable assemblies, consideration must be given to the type of end connectors as well as to the general reeving of the cable in order to insure the best possible cable assembly performance.

WRIGHT *Engine Tests*

FREED FROM FIRE DELAY

72 Cell CARDOX

INSTALLATION AT NEW LOCKLAND PLANT



● Precious time is gained by Wright Aeronautical Corporation through complete control of test cell fires. An installation of Cardox nozzles and piping from the Cardox supply tank gets cold carbon dioxide onto an engine blaze so promptly that damage is minimized. Usually testing can continue without delay. There is no clean-up nor cool-off time to lose and extinguishment by cold CO_2 is so effective that even blazing demonstration fires allowed to get up headway are wiped out in a white cloud in a matter of seconds.

Wright-Aeronautical Installation

At the new Lockland, Ohio plant Cardox protection is built in for 66 propeller test stands, two carburetor stands and four dynamometer stands with the corresponding control rooms for each. Discharge is operated manually from the control room desk, and pipe sizes are adequate to extinguish four test cell fires at once.

Many Other Hazards Covered

This Cardox System is not limited to test cell fires. The carburetor laboratory, remote from the main building, and the separate oil storage and reclaim building are covered by Cardox total flooding for rooms with capacities up to 140,000 cubic feet. In these hazards fully automatic fire detection, pre-discharge alarm, and CO_2 release are employed.

CARDOX CORPORATION
Bell Building, Chicago, Illinois

Hydraulic Pumps

(*Continued from page* 61)

However, a new problem now presented itself to the airplane industry and consequently to the hydraulic engineers. This involved weight control. Heavier and faster airplanes necessarily must have substantially heavier landing gear, and, thus, larger and heavier landing gear actuating cylinders. In many cases these cylinders are 4½ to 6 inches in diameter and weigh up to 25 pounds each empty. Dive flaps also require actuating cylinders of similar tremendous proportions. The problem is not alone that of weight, but of the space required to house these large cylinders in the crowded modern military airplane. The space allowed is actually prohibitive for efficient installation, and the problem could only be solved by making still more demands on the pump by boosting its output pressure.

Inasmuch as the force resulting from an actuating cylinder is the product of the pressure applied to the face of the piston and the square of the piston diameter, it is obvious that increase in pressure will rapidly decrease the cylinder diameter, resulting in smaller and lighter units. It has also been shown that the quantity of oil varies inversely with the pressure for the same horsepower, and the pressure drop through hydraulic lines for the same efficiency varies directly with the flow. Consequently, this results not only in the use of smaller cylinders but also smaller line sizes, and thus lighter weight in quantity of oil carried as well as small actuating units.

The question which now faces us is how high a pressure one can work to and what are the limiting factors. Here again we come to the pump since it is here that the pressure must be produced. Gear pump manufacturers have been able to produce pumps which will produce 1500 pounds per square inch by tightening tolerances and refining materials. Above this the stall leakage makes their use prohibitive. Studies made by some of our leading airplane manufacturers indicated that the best results could be attained by working at pressures from 3000 to 4000 pounds per square inch. This means that the gear pump, so commonly used, must be replaced by another type.

The Pump Engineering Service Company of Cleveland, O., and Vickers Inc. of Detroit, have developed and are now producing in limited production, a multiple piston type pump which will operate efficiently at 2000 pounds per square inch. The Dowty Equipment Company is producing a multiple piston pump of entirely different design which also will produce 2000 pounds per square inch and will unload itself at peak pressure. Eclipse Aviation Corporation produced a multiple piston pump, capacity of 3,000 pounds per square inch for the Douglas DC-4, and at the present time have this pump under additional development. The Simmonds Aerocessories Inc. in New York City has now under development a multiple piston pump which has proven effective operating at 4000 pounds per square inch with the added feature of unloading itself at peak pressure. All these manufacturers are deep in research in boosting the characteristics of their products, and this will undoubtedly result in a complete solution of the high pressure problem in a short time.

With aircraft hydraulic pumps at the peak of interest in the aircraft industry, it would be wise at this time to discuss the various types of hydraulic pumps in use in this industry today, explain their functional differences, the advantages of each and their methods of construction and operation. This may result in a better understanding of the problems in pump design and bring about a closer relationship between the pump manufacturer and the rest of the industry.

Inasmuch as the general aircraftman knows little or nothing of this subject, it would be well to start with fundamental principles and requirements.

The ideal pump must be light in weight, compact in size and highly efficient. Delivery of oil must be as free of pulsations as possible; and the pump must be capable of operating under high speeds without heating excessively under constant operation using a low viscosity fluid with practically no lubricating qualities. It must operate effectively through temperatures ranging from 150 degrees F. above zero to 67 degrees F. below zero, and under atmospheric conditions ranging from sea level to 40,000 feet without cavitation or air inclusion. Although in most cases the pump is directly mounted on the engine and is, therefore, always operating at engine speed, a means must be provided either in the pump itself, or by external unit, to unload the pressure in the pump and to pass the fluid directly to the reservoir at no appreciable pressure. At the same time the system pressure must be maintained so that high pressure is always available when actuation of the hydraulic mechanisms is started.

Since the motive force to operate the pump is in most cases the aircraft engine, a study must be made as to the power required to operate the pump at its full capacity. It has been found that the power required depends on the number of mechanisms which are being operated. Aside from the landing gear and possibly the gun turrets the power required is very small. It would, therefore, follow that the size of the pump is determined largely by the landing gear operating units. Fig. 1 shows a curve of fluid horsepower corresponding to various deliveries and pressures.

In general there are four classifications of fluid pumps. Every fluid pump will fall into one of these classes. In turn each of these classifications can be subdivided so that a general outline of fluid pumps can be made as follows:

Types of Hydraulic Pumps

1. Positive Rotary Pumps (Constant Delivery)
   - a. Gear Pumps
     1. Driver and Driven Gear Wheels
     2. Gerotor
   - b. Vane Pumps
     1. Eccentric Rotor
     2. Cam Riser
2. Reciprocating Pumps
   - a. Angular Piston Block
     1. Constant delivery
     2. Variable Delivery
   - b. Radial Piston Pump
   - c. Swash Plate
   - d. Hand Pumps
3. Centrifugal Pumps
4. Screw Pumps

For the purpose of breaking this subject into two general groups to be discussed in two succeeding issues, this particular article will be confined to the discussion of Positive Rotary Pumps. Of these, the gear pump is by far the most widely used type and sufficient space should be devoted to cover its construction and operation.

In general the gear pump consists of two revolving gears, one of which drives the other. The clearances between the gear teeth are held very closely as are the fits between the gear outside diameters and the periphery of the housing in order to obtain highest efficiency. Fig. 2 illustrates the arrangement of the gears in their housing and this figure also demonstrates the gear pumping principle.

The Gear Pump operating principle is as follows: (Reference Fig. 2)

The upper gear is connected by means of a universal joint coupling to a male spline shaft which fits into a female driving spline in the accessory case of the aircraft engine or electric motor (See Fig. 3). The lower gear floats in a closely fitted housing and is driven by the upper gear. The diameters of both gears as well as their thickness and tooth form are equal in every respect and should be interchangeable with each other. The fits between both gears with their housing should be same at about .002 inches clearance. The rotating action of the gears creates a suction in port A, drawing the fluid into the pump as shown in View 1 of Fig. 2. From here the fluid is carried between the teeth of the gears around their periphery as shown in View 2 of Fig. 2. It is then carried to the opposite side of the pump and discharged through port B since the meshing of the gear teeth

(Turn to next page)

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FILTERS FOR AIRPLANE ENGINES

(*Continued from page* 172)

forces the liquid out as shown in View 3 of Fig. 2. This results in a smooth, even flow of fluid, the rate of which is dependent only on the speed of the rotating gears. The flow is almost 100% in volumetric efficiency at maximum pressures, but the system has the disadvantage of being rather noisy at very low pressures.

The gear pump is considered to be of the positive displacement type because all the fluid entering the pump must leave by the discharge port as the gears mesh. The fluid cannot churn around inside the body or work its way between the meshing of the gear teeth. Also this type of unit must be a constant delivery pump as it is not possible to vary the output except by changing the width of the gears, or changing their diameters. This, of course, means that a complete new pump design is necessary for every change in output inasmuch as the close fits required in this pump do not allow for dimensional changes of any single working part.

Nearly all gears used in hydraulic gear pumps are simple Spur gears. However, Herringbone gears can be used to boost the efficiency of the pump and to cut down noise. The cost of the Herringbone gear, which is "V" shape across the face, is excessively high and its advantages do not warrant its high cost in any appreciable application.

To date the gear pump has been the principal source of hydraulic power supply by the aircraft industry in the United States. This type pump can be made easily and cheaply, but if high efficiency and high pressures are desired, its disadvantages become apparent. Although the clearances around the periphery of the gears and housing, and between the gear ends and the casings, are held to a minimum, there is a certain amount of leakage at these surfaces which increases with higher pressures. The light alloy castings from which the housing are made have a high coefficient of expansion requiring greater clearance under higher temperatures, and consequently there is greater breakage.

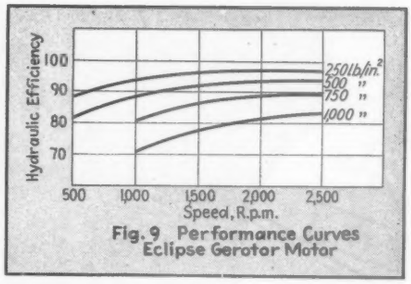

Fig. 9 Performance Curves Eclipse Gerotor Motor

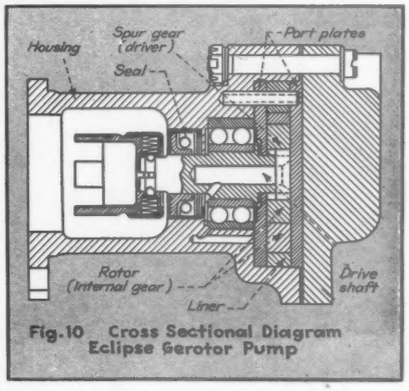

Fig. 10 Cross Sectional Diagram Eclipse Gerotor Pump

The Pump Engineering Service Company of Cleveland, Ohio, has done much in the development of gear pumps used in the aircraft hydraulic industry to date, and it is supplying by far the great majority of this type of pump used in the aircraft industry for hydraulic actuation. Fig. 4 shows a three-quarter view of this pump. A cut away section of the same unit is shown in Fig. 5. In this illustration one can see the arrangement of the gears in their housing as well as the bearings and general bearing and sealing members. A cross-section of the pump is shown in Fig. 6. In this drawing, which is typical of all the gear pumps in the industry, the detail of all the parts which constitute the pump can be easily seen. The same type of pump is also supplied by the Eclipse Aviation Corporation and is used in large quantities as a motor driven unit for hydraulic power operation of flaps and landing gear.

With reference to Fig. 6, it should be noted that the pump is constructed as follows: a pair of closely meshed steel gears contained in a bronze liner which is pressed into an aluminum alloy housing. The upper gear is connected by means of an Oldham coupling to a driveshaft which is held in position by a closely fitted bearing to an adapter housing fitted to the pump housing. This adapter is fastened directly to the engine accessory case or to an electric motor (as shown in Fig. 3) which has a driving member to fit the driveshaft. The gear is bored to incorporate a ball check valve so that the seal will be kept primed with oil and thus prevent air from being drawn into the pump. Any oil which may bypass around the gear shaft can be drawn out through the check valve into two drilled holes leading to the intake port drilled in the pump cover. The cover is an aluminum alloy casting drilled on one side and fitted with two removable bronze bushings. Two ports are tapped on the outside and designated as intake and outlet ports.

Hydraulic balance is accomplished by placing the suction and pressure ports in quadratic arrangement so that two suction, and two discharge ports, are diametrically opposite each other. Performance curves for these pumps are given in Fig. 7.

The second type of gear pump is known as the Gerotor pump. It has been widely used in the industrial machine tool and oil burner industries for many years and was introduced into the aircraft field in 1935. An example of the Gerotor type pump made by the Eclipse Division of Bendix Aviation Corp. is shown in Fig. 8. The performance curves of this pump are shown in Fig. 9. This pump operates satisfactorily at pressures up to 1,000 pounds per square inch at 4,000 r.p.m. Output is directly proportional to speed and is but little affected by pressure.

The construction of the Gerotor pump is as follows: The rotor which is an internal gear with special tooth form is fitted closely into a steel or bronze liner which in turn is pressed into an aluminum alloy housing. A spur driving gear, having one tooth less than the internal gear, is set eccentrically into the internal gear. The width of both gears is exactly the same and the clearances between the teeth when meshing are held very close. The internal gear and its housing and the drive spur gear are sandwiched between two cast iron plates in which are the intake and outlet ports. These plates are held to close tolerances, allowing clearance between them and the rotating gears of about .005 square

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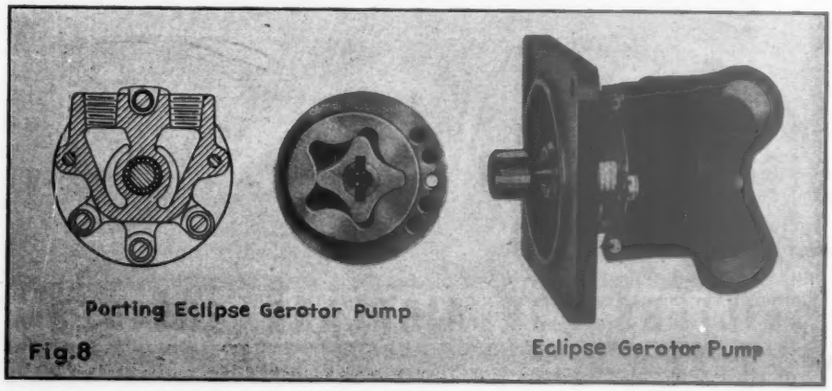

Fig. 8

At Uncle Sam's Front Door

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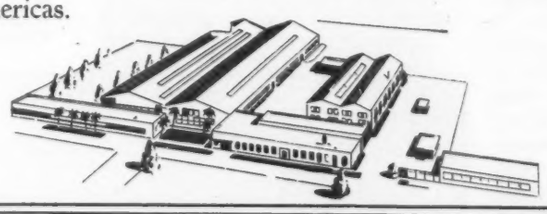

INTERCONTINENT *Aircraft* CORP.

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inches. The driving gear is keyed to a drive shaft which is mounted in a sturdy ball bearing, which in turn is mounted in a front housing that can be mounted directly to the accessory case of the engine. The rear housing also supports the drive shaft by means of a needle bearing and is drilled and ported to take the intake and outlet connections. The whole unit is then bolted together in a sandwich with very thin or no gaskets between the sandwiching members. See Fig. 10, Cross Sectional Diagram of Gerotor Pump.

The pumping principle is rather simple. The intake and exhaust ports as seen in Fig. 8 are diametrically opposite and moon shaped. Their length is determined by the travel of the gear teeth in meshing and unmeshing over them. The fluid is sucked into the pump as the gears pass over one port and is carried over to the opposite side of the pump where the meshing of the gears forces the fluid out of the discharge pump. As the gears travel around them and unmesh a suction is created just over the intake port and again the fluid is drawn in, etc., and etc.

This type pump is compact and quite small. The Gerotor has the drawback common to all gear pumps. It has limited maximum pressures, and is susceptible to damage by dirt or gut in the fluid due to the fine tolerances.

The Vane type pump, illustrated in Fig. 11, has not found many applications in the aircraft hydraulic industry because of its inherent defects under high pressure. The pump is highly efficient under low pressures and has found many applications in the aircraft industry where pressures above 400 pounds per square inch are not required. Its greatest application, however, is in use as a fluid generator or motor where pressure from the system drives the motor which is coupled directly on to a fuel pump.

Fig. 11 illustrates a cross-section of the Vickers-Vane pump. This pump consists of a slotted rotor in which is inserted a multiple number of flat steel blades. Instead of the rotor being eccentric to the housing as in conventional arrangement, the rotor is concentric with the pump but the vanes ride along an eliptically shaped hardened steel casing. Rotor blades' widths are held to the same thickness as the rotor and in some cases are surface ground together to insure exact thickness. The casing is held from .002 to .003 inches thicker than the rotor and blades. These parts are sandwiched between two bronze liners containing the port slots and these are again sandwiched with the outer duraluminum housing which contains the intake and outlet ports. This whole assembly is held together by means of through bolts carrying through the various layers.

As the rotor rotates, the steel blades are thrown against the eliptical face by means of centrifugal force. In some pumps of this type small compression springs are placed in the vane slots between the vanes and the rotor axis to aid in exerting an outward load against the cam face. As the vanes revolve, fluid is drawn in between the vanes from the suction ports into the larger volume section of the casing, and then carried around in such a manner that the volume decreases thus building up pressure at the discharge ports. Typical performance curves for this pump are shown in Fig. 12.

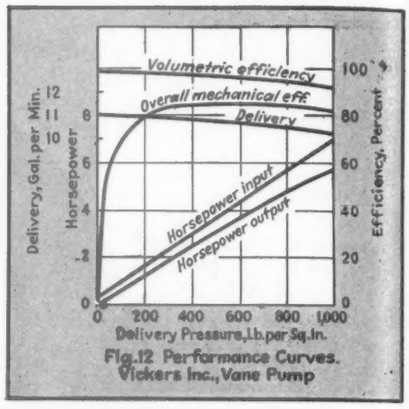


Fig. 12 Performance Curves. Vickers Inc., Vane Pump

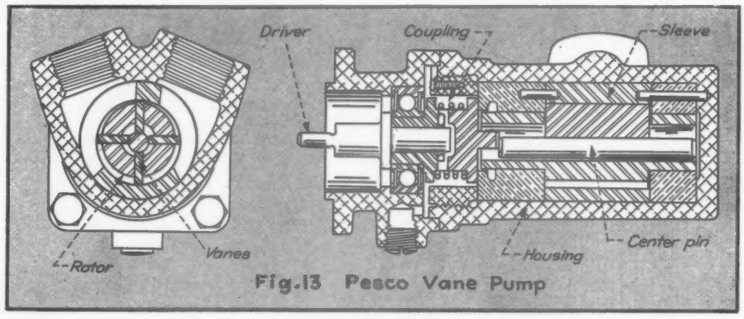


Fig. 13 Pesco Vane Pump

Fig. 13 illustrates the Pesco high pressure vane pump. This pump consists essentially of an aluminum alloy housing containing a hardened steel sleeve in which a hollow steel rotor is driven by means of a coupling which mates with the engine drive coupling. The base of the sleeve is eccentric with the axis of the rotor. This rotor has four equally spaced slots in which steel vanes are contained. These blades move in and out of the slots as the rotor turns and maintain constant contact with the base of the sleeve by means of a steel center pin. Performance curves for this pump are shown in Fig. 14.

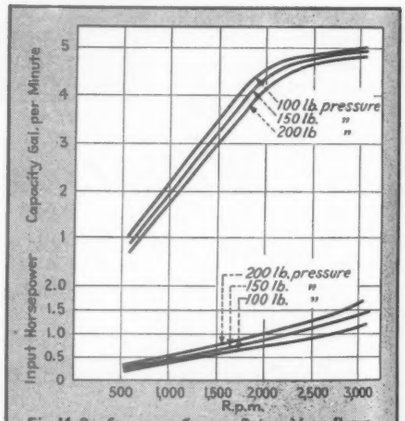
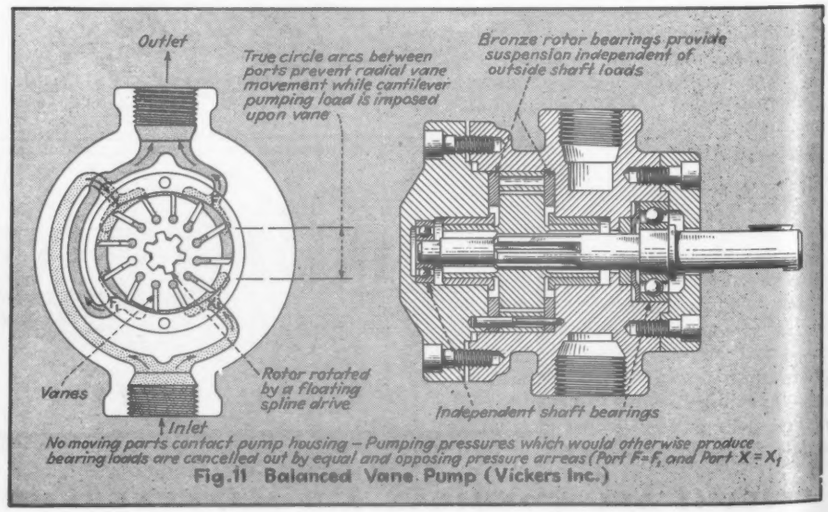


Fig. 14 Performance Curves. Pesco Vane Pump


Outlet
True circle arcs between ports prevent radial vane movement while cantilever pumping load is imposed upon vane
Bronze rotor bearings provide suspension independent of outside shaft loads
Vanes
Rotor rotated by a floating spline drive
Inlet
Independent shaft bearings
No moving parts contact pump housing – Pumping pressures which would otherwise produce bearing loads are cancelled out by equal and opposing pressure areas (Port F = F, and Port X = X,
Fig. 11 Balanced Vane Pump (Vickers Inc.)

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(*Continued from page* 81)

kind of work required is all important. Where parts or assemblies of large size are involved, prime contractors might well consider the wisdom of providing scale models, photographs and simplified diagrams. Visiting subcontractors at the table of Curtiss-Wright Propeller Division were able to handle actual parts of the Curtiss Electric variable-pitch propeller and quickly decide the possibilities of being able to make it. These decisions were not so easy for some in instances where manufacturers brought only blueprints and specifications.

Odlum Heads Contract Distribution

In this connection, Floyd B. Odlum, recently appointed Director of the new Contract Distribution Division of OPM, announced preparations are underway to conduct a great number of defense production clinics in numerous industrial centers. In addition, traveling exhibits will be transported from point to point to reach operators of small factories in every part of the country. Such industrial centers as New York, Chicago, St. Louis, Philadelphia, Cleveland and San Francisco will be selected for permanent exhibits in which the "bits and pieces" shown will be changed from time to time as different and ever-changing needs develop.

Odlum is approaching his task along three principal lines.

(1) Action through the Government's purchasing divisions in breaking up large contracts and in promoting subcontracting in other ways.

(2) Finding ways to assist prime contractors in distributing larger portions of the orders they are now filling to smaller units.

(3) Organizing and mobilizing smaller manufacturers so that they will know what they can do and how to go about it.

He considers most urgent the problem of converting to defense production factories being cut off from civilian production on account of shortages of raw materials and priorities.

One of Mr. Odlum's first acts was to request 56 companies holding major defense contracts to appoint their ablest executives to take charge of subcontracting to small enterprises and act as liaison officers between their companies and his division.

The work of the division is being decentralized as much as possible so that no small manufacturer need feel it necessary to go to Washington. The 39 field offices taken over from the former Defense Contract Service are being expanded daily and soon will number over 100. To be organized along state lines, each state will have a main office with others reporting to it, depending on the amount of industrial facilities in the area. The field offices will cooperate closely with all state agencies working toward the same objective and in all the principal offices there will be representatives of the Army, Navy and Labor Division.

The War and Navy Departments and the Maritime Commission have established contract distribution divisions which are cooperating with OPM and working toward the same end through their own purchasing agencies. Arrangements are being made whereby the armed services, when so requested by OPM, may negotiate contracts instead of letting competitive bids, at prices up to 15 percent above current quotations. The services may also grant orders to a "responsible defense association or corporation" organized so that manufacturers may jointly handle work that they could not do with their individual equipment. In certain cases, bid or performance bonds may be eliminated. Already, the Army is dividing awards so that part of the work may go to other than the lowest bidder.

Financial Aids Studied

The credit resources of banks are being mobilized also to assist small businesses in their efforts to fit into the defense scheme. Mr. Odlum feels that it is the responsibility of the financial community, public and private, to see that a manufacturer who has a defense prime or sub-contract or whom the armed services wish to see receive such contracts, shall not fail in the attempt because of lack of money. To this end, a financial section has been established in Odlum's division to cooperate with commercial banks, the RFC, and Federal Reserve Banks so that these contractors can be brought into touch with all available financing facilities. Every request, however, will be discussed with the contractors' local banks first so that all financing possible will be handled in the manufacturer's own community. Where requirements cannot be met locally, the financial section will endeavor to satisfy the need through all other available sources.

Through the formation of two advisory groups, the Small Business Committee and an Engineering Committee, some of the finest minds of the country in the fields of industrial, management and production engineering have been enlisted to assist in solving the twin problems of utilizing all available production facilities for defense and averting the social catastrophe which would result from widespread ruin in our national community of small business.

Pitfalls to Consider

Here we have observed the details of a major operation in the conversion of the United States' peacetime economy toward a wartime basis. There is a real danger here. It lies in the fact that independent small businesses formerly engaged in the manufacture and marketing of complete articles are now faced with the prospect of conducting a single operation in a larger industrial process. They will act as feeders to big companies and the government, thereby losing some of their independence and individuality.

Much can be done to prevent a permanent blackout of independent small business if government will keep constantly in mind that this is purely a temporary expedient for an immediate purpose — to help win a war — and through intensive educational efforts keep alive the idea of flexibility in our industrial community so that the inevitable post-war readjustments will not give rise to feelings of despair and futility on the part of all those who then will no longer be told what to do by the government.

It is never too early to plan: like the case of the fashionable lady who consulted an eminent psychologist about helping her instill in her son the rudiments of discipline and good behavior. "How old is the boy?" he asked. "Three," beamed the mother. "Madam, you are three years late," said the psychologist. Tragedy already will have occurred unless, as a nation, we incorporate in our defense efforts now the nuclei of ideas and plans which will facilitate an orderly return to peacetime pursuits. Possible alternatives are complete social and economic collapse or a highly centralized economy dangerously susceptible to the forms of fascist dictatorships against which we are striving in the present.

Groundwork must be laid now for eventually reversing the flow of raw materials back into consumer goods. Initiative and imagination of these small businessmen must be stimulated to meet the challenges of a difficult post-war period with ideas for new consumer goods and new services. Those who can return to their former activities on a similar scale should do so by all means. But the world and people change a lot in a few years. Inevitably, many who have dropped their profitable pursuits to put a shoulder to the wheel will deliberately have to seek out and find new uses for their energies and skills. If this can be done on a national scale, through the coordinated effort of all business and the government, the in-

(*Turn to page 194*)

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T. P. Wright

(*Continued from page 47*)

deliveries. Before discussing these graphs, it is perhaps well to review the background and the methods used in preparing the curves and giving the forecast which they show.

In my first article appearing in the June 1939 issue of AVIATION, entitled "America's Answer," I outlined the basic method of production analysis. Briefly stated, the method is to establish parameters or yardsticks governing output based on actual experience, and after altering these parameters as needed, because of changes in factors involved, and general judgment of the situation, to forecast what can be expected in the future. Parameters were established involving output per unit of floor area and labor man-hours with the ob ject of determining capacity, using these factors primarily, but qualified by those more indefinite ones, such as the ability to supply tools, procure management, train labor, and provide materials, based on judgment of what the country as a whole could do.

In April, 1940, you published my article "Winged Victory." In that article I brought up to date the forecast of the previous one, changed only because of the introduction of new airplane programs. I also made bold to apply the method to forecast the probable production for Germany and England and their Allies. The basic facts on their past record came from observation and study in Europe on the occasion of several trips made to those countries from 1934 to 1938. In that article was forecast the possibility of victory for the Allied cause in 1942. This was premised on a continuing superiority on the sea, a continuing advantage in recourse to world markets, the gradual attainment of air supremacy, and a continuing equality on the land. This latter premise has not maintained, and the war will be prolonged. However, I still feel that the supremacy in the air which is being gained by the Allies, with our help, will bring them ultimate victory, possibly in 1943.

In my July 1940 article, "50,000 Planes a Year" the parameters established in the earlier studies were applied to a program of our own which the President had just announced. The article discussed a suggested method of expansion which was first to place the load on the existing aircraft industry, then to bring in other large industries such as the automobile. This course has, in general, been followed and I feel that to this we may attribute to a large extent the success that has been attained.

Finally in the article of last January "The Truth About our National Defense Program", after outlining the fundamentals of defense in general, including both the psychological and material factors, I drew up a revised set of curves to furnish a forecast of what could be expected in the United States in yearly and monthly rate of production; in expansion of factory area and labor force; and finally the relative position of the air forces of the world both as to rate of production and total strength. These curves are reproduced here with a point shown indicating our actual accomplishments.

The problems of Government in getting under way on this program were discussed; also the controlling importance of air power in determining the outcome of the war. There has been much improvement in our defense setup in Washington since that time, although there are still a number of things which undoubtedly need to have further corrective measures applied.

The question may well be asked, "It is true we have quite closely approximated our forecast for U. S. production, but how reliable are the curves as regards England and Germany?" In the case of England, from numerous unofficial conversations I have had with Englishmen and with Americans returning from visits to England, I can say that the forecast for English productions appears good. Then, as the method used for the United States and England was the same as that used for Germany, is it not reasonable to suppose that the forecast for Germany also is close to the truth? Study of all available information on what is happening in Germany leads to the belief that it is.

What of our own air force? Our training program has progressed well. We would perhaps have liked to increase our own forces by greater numbers of tactical units than has been found practicable to allot from the standpoint of giving aid to England and her Allies, who are performing with such great credit on our common front. All in all, the division of tactical units between those which are retained at home and those which are sent abroad has been a proper one.

Our forces are getting some training in tactical operations, they will get more as time goes on. We have given to England a very substantial and a very much appreciated supply of tactical airplanes which have served and are serving with great credit on the several battle areas in Europe and North Africa.

There follow several comments which may be interesting. It is noteworthy that *the rate of production increase for aircraft in the United States is greater than for any other country in the world at any period.*

Next, I would like to re-emphasize the excellence of American equipment. It is, considered as a whole, unsurpassed by any other country.

Then let us see the situation regarding relative air strength of the two contending groups of powers. Surely the entrance of Russia into the war on the side of the Allies far more than offsets any effort which the conquered nations have been forced to contribute. Therefore, in appraising the curves showing the rate of production of the contending powers and the size of their air forces, I feel that it is conservative to use the same critical dates that appear in the curve of the January article. I am therefore still of the opinion that, without counting Russia, the rate of production of England, augmented by one-half of the U. S. production, is now greater than the output of Germany and Italy plus the production of conquered countries; and that the total air power of the Allies will be greater than that of the Axis powers early in 1942.

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to several times since my January article was prepared. Therefore, the curve for monthly production should now be extended by a straight line running from the point of maximum slope at a similar acceleration to attain a peak production rate of well over 3000 planes per month, by the middle of 1942. The point of monthly production output to which it goes thereafter will be dependent upon the addition of new programs this winter and next spring, but a rate of 50,000 planes per year is in sight!

Here I would like to call attention to a factor which is of great importance; namely, the increasing size of the aircraft we are producing. First, the proportion of tactical units when compared to training planes is increasing; but there is another change in process which is even more important: that is, the increase in size of the tactical units themselves. We have read much of the so-called 500 four-engine-bomber per month program. Perhaps few realize what a tremendously increased burden is placed on the industry by this change in type. Although in the next year we may almost double the *number* of aircraft produced per month, it should be noted that in terms of *weight* of airplanes produced (or in terms of total horsepower of the engines with which they are equipped), there will be a three- to four-fold expansion required. Thus the magnitude of the task ahead is even more impressive when this added factor of size increase superimposed on numbers is considered.

I think it is extremely important that the morale of the American people should be raised. I think now that this can best be done by driving in an appreciation of the fact that the job we have done and are doing is very creditable, and that the job which we will do will far surpass what has been done in the past. The truth concerning our accomplishments of the past year and a half should aid in showing that the detractors of our effort are wrong. I do not wish to indicate that the situation is not serious in the extreme, and that there is not a need for an ever increasing effort and sacrifice. I simply state that, in my opinion, if our morale is raised to the point where it should be, this increase in effort and a commensurate increase in production definitely will come to pass.

In 1940 we rolled up our sleeves and got production started, resulting in a "trickle" of planes to England; in 1941 production has gotten well under way, and as President Roosevelt said, "The stream becomes a river"; in 1942 "The river will become a torrent"; and in 1943, "We will engulf this totalitarian tyranny which seeks world domination."

Sincerely yours,

T. P. Wright

They Wear the Pants

(*Continued from page* 55)

her job. Of course we have an intensive trade extension training program available through the Federal Gov't. National Defense Training scheme, and about 10 to 15 percent of the women in our plant take advantage of such training to better themselves in their present jobs or to advance to more responsible jobs.

Although men have long been accustomed to ruling the roost in aircraft work, they soon grow used to the idea of working with women. As a matter of fact the women are welcomed into the local union. The men and women work well together. We have a rigid rule that any man will be dismissed for any undue familiarity with one of the women workers but it has been invoked only once in six months time. The women themselves are of mature age, averaging about 27 yrs. old, and more than two-thirds of them are married, with more than half of them having one or more children to support or help support.

Special rules and special equipment required for women workers are not much of a problem. We require that all women wear slacks, as dresses are too much of a hazard in a shop, especially adjacent to power driven machinery or equipment. Also we insist on solid toe shoes to give full protection to the feet. Special rest benches are provided for each department where women are employed and separate washrooms had to be installed, of course. At first we used the women on the day shift only, due to a California state ruling prohibiting women from working in industrial establishments after 11 p.m. Recently this was amended to permit women to work until midnight, and we now have feminine help on both day and evening shifts. Work must be planned so as to avoid overtime since women are not allowed to work more than eight hours in any one day or 48 hours in any one week.

Women in the Shop

Before hiring women, and continuously since then, we have made studies to determine what types of work they could perform to advantage, and what limits should be placed on their employment. We know that, generally, women must not be given any work requiring continuous heavy muscular exertion or lifting. They should not be required to move around too much and generally work best sitting down. They should not be expected to reach too far, nor to reach up above their heads, nor to work where climbing or crawling over jigs or

A number of women have been trained as welders, and do a good job of it.

Riveting a center wing rib at Vultee.

airplane structures is required. But women have proved ideally suited for all sorts of delicate work requiring precision and speed, and have proved quite handy with tools and micrometers.

Our first use of women was in the trim department, cutting and sewing fabric for control surfaces, etc. This is a type of work long done to good advantage by women and is in a field where they naturally excel. The first shop work on which women were tried was that of assembling electrical parts and wiring for control panels, fuse boxes, etc. By making a careful study of work sequence, and by arranging cables, terminals, etc., in logical fashion, it was possible to show a material reduction in assembly time on such work.

Encouraged by this success we turned to the machine shop and began to place

(*Turn to page* 186)

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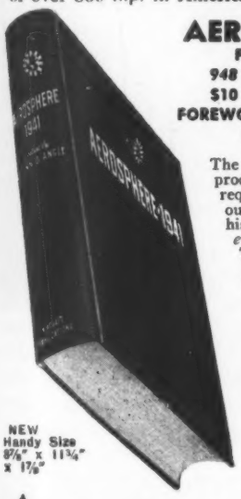

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Russian Aviation

(*Continued from page* 51)

Some of the goods carried by air transports are vegetables, fruit, fish, cotton, medicines, spare parts for factory machines. In the last three years the time of delivery of perishable merchandise has been cut by more than 50 percent.

The Soviet Union is the only country that operates a regular airline serviced by lighter-than-air craft. Moscow is linked by a dirigible line with Sverdlovsk, the important industrial metropolis of the Urals. For about four years the semi-rigid DP-9s have been in use there. Filled with non-inflammable helium (the USSR is the only country, aside from the U.S., that has its own deposits of this gas in adequate quantities), this type has a capacity of 25,000 cubic meters. Its comfortable passenger gondola has sleeping accommodations for 16, a salon, buffet and smoking room. All captains and copilots of lighter-than-air ships are graduate engineers. A good many pilots, navigators and mechanics on these lines, as well as on regular airlines, are women. In Moscow there is a school for advanced training of both male and female dirigible personnel.

The Civil Air Fleet does not confine itself to transport work. Distinctly apart from the wartime medical service there is a so-called sanitary aviation. Planes take aid and medical personnel to remote, isolated spots of the country. If no landing fields are available, the physicians, nurses and surgical instruments come down to the patients by parachute. Sick persons from a distant outpost are often rushed by air to a medical center.

In 1939 Soviet ambulance planes had flown 70,372 hours, brought doctors to 11,372 patients, carried 2,840 sick people to hospitals. In the Russian Soviet Republic alone aviation rendered medical aid to more than 40,000 persons that year.

Sanitary aviation is employed to exterminate malaria-breeding mosquito spots. The splendid harvests of corn, cotton, sugar beet in recent years have been due in no small measure to the dusting and spraying of the fields by planes.

That dread scourge of agriculture, the locust, has its most formidable enemy in aviation. Breeding in the south of the country, particularly in the regions of the Amu-Darya and Syr-Darya and on the shores of the Aral Sea, the locust is now the quarry of intensive chemical war from the skies. In one hour an airplane covers 150 hectares of farm land. In this way century-old breeding grounds of the Asiatic and Morocco locust were completely purged of this parasite.

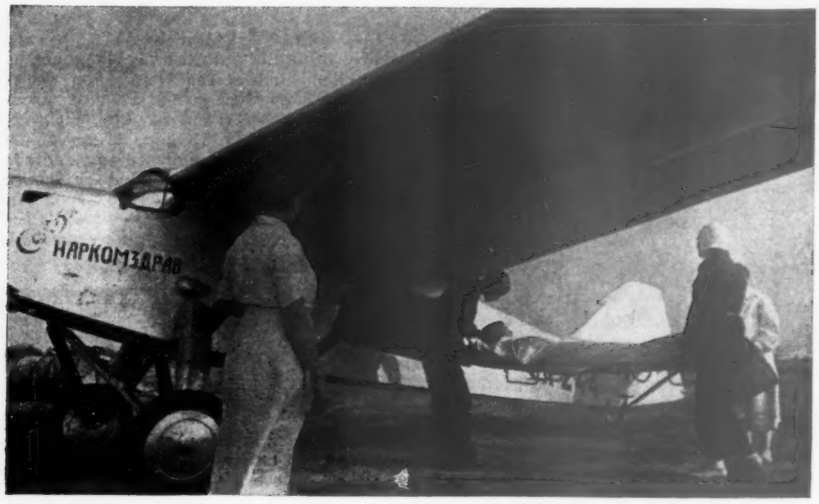
Similar techniques were enlisted to destroy pests that damaged the cotton crops in Central Asia, Azerbaidzhan, Ukraine, Northern Caucasus, Turkmenia, Kazakhstan and Uzbekistan.

During the Second Five-Year Plan chemicals were sprayed by aircraft over 488,000 hectares of land sown with cotton. In 1940 a cotton area of 80,000 hectares was covered, in 1939 alone 210,000 hectares of cotton fields had been cleared. By spraying or dropping poisoned bait, the pests are destroyed 30 times faster than by hand. The recent years have seen the use of newly-developed airplane atomizer on the beetroot weevil. This pest was destroyed on territory of 96,000 hectares by last year.

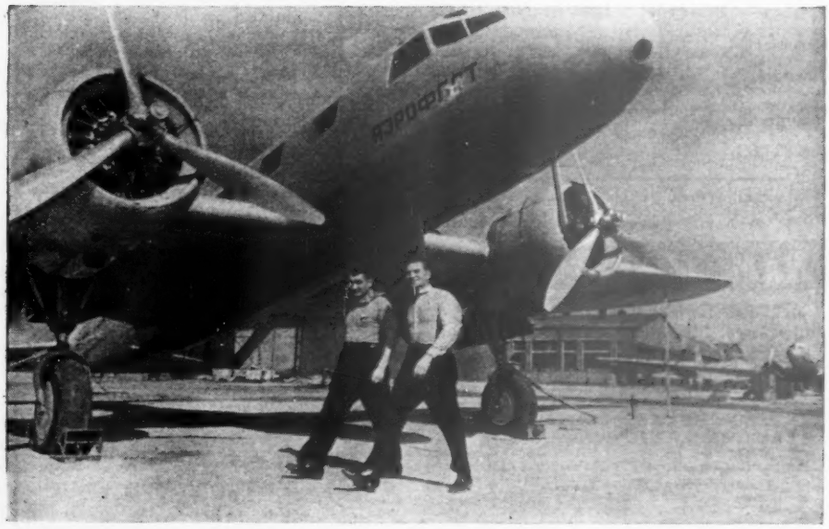
Aviation is used for forest fire patrol work. It helps to detect and prevent fires and also delivers firemen and their apparatus wherever required, sometimes letting them down by parachute. This department of the Civil Air Fleet has within its jurisdiction over 395,360,000 acres of forest land. Here, too, harmful insects and animals are hunted from the air. Every year new forests are sown in the USSR from aircraft.

Soviet fisheries also benefit from the work of the Civil Air Fleet. Fishermen are assisted during the shoaling season with aircraft spotting fish and directing surface vessels to profitable locations.

Also systematic is the part of the airplane in Soviet science. Hundreds of exploring expeditions make use of aircraft. In the Soviet Arctic a thick network of air routes links the polar stations, transpolar ports and new indus-



Since the German invasion, many Soviet civil planes have been used for ambulance work and for many other war duties.



Russia has many kinds of modern transports, which continue to play an important role in carrying key personnel and troops.

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Russian Aviation

(*Continued from page* 184)

trial cities with one another and with the nation's centers outside the Far North. Perhaps the world's longest airline is that between Moscow and Anadyr. Passengers and express leave Moscow regularly for the far-off cold Chukhotka. The planes fly east along the Arctic Ocean coastline. Machinery, foodstuffs, mail and workmen are carried by air to the Arctic, bringing furs and other local products on the return trip.

Military value of the Northern Sea Route is enormous. It is there that the Red Navy Northern Fleet makes its home. It is there that Soviet naval units have lately been sinking German submarines. Were it not for the continuous cooperation of Arctic airmen, the Northern Sea Route's shipping could not function as effectively as it does. These fliers now carry on year-round reconnaissance and reporting of ice movements. In planes of wide range they scout over the Laptevykh, Kara, Eastern Siberian, Chukhotsk Seas and other waterways. They inform by radio the pilots of surface vessels regarding the condition of ice and help them choose the shortest and safest itineraries. This flying job is so complex, difficult and responsible that the very best of airmen are assigned to it.

Aviation may be credited with the opening up of new frontiers for industry, agriculture and civilization in general. Far East has been the beneficiary no less than Far North. New population centers are springing up and huge stretches of farm land added as each year witnesses the opening of many hundreds of miles of air routes.

In the Pamirs, the Roof of the World, there is the Gorno-Badakhstan area which was formerly isolated from the rest of the world nine months of each year. During the three summer months the road to it led over craggy mountain ranges and turbulent streams. The inhabitants knew nothing of the existence of automobiles and other vehicles, but since 1929 they have been acquainted with airplanes and pilots.

A few words are in order about ground equipment. Radio beacons are functioning on all principal routes, including those in the Arctic. Airways used in night flying are lighted throughout, except in blackouts. Some of the largest airports have blind-landing installations.

Meteorological services are especially good because they are augmented by more than 50 weather observation stations in the Arctic which is known to science as the "weather kitchen." The Aerological Observatory is the headquarters which coordinates all aeronautical weather services. The surfacing of landing strips, maintenance of good emergency fields and other aids have led to the abandonment of the wintertime practice of exchanging wheels for skis on all main routes.

The Soviet national budget still provides generously for development of non-military aviation because it has more than amply justified itself in the war effort, tellingly proving the thesis that while the army, navy and air force protect the civilians of the nation against the invaders, this is one of the foremost factors in the civilian abetting of the armed services.

They Wear the Pants

(*Continued from page* 182)

women on such simple operations as burring and filing of small parts. Following this they soon proved their mettle on light drill press work performing drilling, spot facing and reaming operations. Here a healthy competitive spirit developed. The women soon demonstrated that they were out to prove that they were no ersatz for the men. Foremen reported that the women coming on the job at the beginning of a shift would first check up to find out how many parts the male operators had turned out on the previous shift. Then they would dig in with a will and not relax until they had surpassed the best production record of the mere men.

As one example of finger dexterity in this regard, a particularly difficult operation had developed into a minor bottleneck. A large number of small $\frac{3}{16}$ in. steel pins had to be drilled with a $\frac{1}{64}$ in. hole. Best production any of the men operators could hit was about 650 units per shift. The nimble fingered young lady who tackled this job turned out 825 units the first day on the job, and on her second day she topped the thousand mark and stayed above it for the balance of the job.

Two of our women drill press operators have now graduated to milling machines and others are ready for advancement to milling machine work as opportunities for advancement occur. These women have proved very satisfactory on milling operations and we expect to place other women on screw machines and other light equipment such as some of the turret lathes.

While we have no thought of ever placing women on the heavier riveting work, their light touch has proved of advantage on a number of delicate riveting operations. They have also done well on the small riveting machines where semi-automatic riveting of small assemblies is performed. Welding is also a field for female talent. During the last World War women were widely used on welding work, where their fine sense of touch proved of advantage in forming good welds rapidly. This is again proving true and we already have two women welders at work, with a number in training. So far we have only used the women on gas welding of aluminum but they will probably find employment soon in electric welding work, especially on the fittings, small sub-assemblies, and other bench work.

Women are ideally suited for inspection work of many kinds. Their natural dexterity and usually keen eyesight helps them to turn out inspection work on a production basis equal to the best male standards. They also find a place in the paint shop, especially in feeding parts to the power conveyors, turning them over between sprayings, etc. Some spray painting is being done by women, usually on small parts. They have learned this work with great rapidity.

We have now carried our use of women right up into the final assembly line. Here they play an important part at many of the assembly stations where light parts are attached to the fuselage. This work is facilitated by our powered conveyor line and by the fact that the fuselage frames are carried in a position permitting an unobstructed floor and allowing all work to be done from a normal position. Even on the engine section assembly line the women are playing an important part. This line is carried on a mechanical conveyor while fuel and oil lines, ignition harness, controls, etc., are assembled to the engine and its detachable mount. Much of this important work is now being done by women.

Six months of actual use of women in aircraft production work at Vultee has proved that the use of women in aircraft manufacturing work has progressed far beyond the experimental stage. Their help throughout the aircraft factory is already making it possible to speed our national defense program through the building of better airplanes in less time than could be done without them.

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Fig. 928

A popular "Hallowell" model having an all laminated wood top. Drawer is extra. Pat'd. and Pat's. Pending.

Fig. 1729

A smart and useful member of the DeLuxe line of "Hallowell" benches. Interchangeable drawer and shelf units.

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Transoceanic Flight

(*Continued from page* 59)

A third is a propeller design which dependably converts horsepower into thrust with high propulsive efficiency throughout a wide range of conditions and settings. Above all, there must be a harmonious marriage of these three elements into a highly productive whole —a task of sometimes baffling complexity.

To achieve the first objective, designers of Pan American Clippers have consistently created large aircraft of unprecedented structural efficiency, aspect ratio, wing loading, and aerodynamic efficiency. Toward the second objective, the brilliant work of American engine builders has met with unceasing success. The first engine used in transpacific flight had a specific fuel consumption of about .46, a then unprecedented figure, and its manufacturer made a substantial contribution to our operating technique. Each subsequent engine achieved new lows in fuel economy (.44 and .42), until now the engines in the Clippers are operating at about .40 specific fuel consumption. By the same token, propeller efficiency has progressed steadily upward to its present level of 87 percent, always with great mechanical reliability. Bear in mind that each one percent betterment in engine or propeller efficiency means approximately one more transocean passenger whose voyage, in these days, is often of real national significance.

A point not to be overlooked is that the state of the art is constantly advancing, therefore a transocean airplane, with its engines and propellers, must frequently be modernized while in active service. The burden thus placed on the airline engineering staff is a heavy one, rewarded only by the resulting improvement in long-distance commercial performance.

To develop a simple practical technique for transocean cruising control for a specific aircraft is a substantial task. The objective is to prescribe the cruising condition for each altitude, gross weight, and headwind at which the ratio, "ground-miles made good per pound of fuel," will be a maximum. Phrasing it differently, the cumulative effect of L/D, specific fuel consumption, and propeller efficiency, must always be a maximum, headwind considered. The first task, therefore, is to calibrate the airplane, engines and propellers with the greatest possible thoroughness. In general, the airline engineer can count on securing complete data from manufacturers on:- (1) the horsepower available from the engines for all conditions of R.P.M. and altitudes; and (2) the propulsive efficiencies of the propellers under all practical operating conditions. To supplement these, the operator must himself run long tests on (3) fuel consumption characteristics and (4) horsepower required. Determining fuel consumption characteristics under different conditions of altitude, R.P.M. and manifold pressure is comparatively simple because there are but three main elements to be held constant. Horsepower-required tests are comparatively tedious, and unless accurate dynamometers are mounted in each power plant the results achieved may be considered at best only a close approximation. However, if done skillfully and patiently, reliable polar curves can be developed, even without torque indicators, which can be used for performance computations at other gross weight and altitude conditions.

Once in possession of such data, the engineer can prepare sets of readily usable tables or curves which prescribe optimum air speeds, R.P.M.s and manifold pressures to insure a maximum ratio of "ground-miles made good per pound of fuel" in the face of any wind condition, temperature and altitude.

In this connection, reference should be made to two important concepts. First, the airspeed indicator is vitally important, not only for test work but because it is the simplest and most direct means whereby the pilot can achieve the prescribed cruising regime. Because of its importance, Pan American frequently and routinely calibrates its airspeed systems. Second is the fact that maximum fuel economy is achieved at maximum allowable B.M.E.P. Therefore, so far as operating limits permit, the engines are cruised at full throttle and speed is controlled by altering engine R.P.M.

Scientific management of an actual flight obviously starts with the weather man. Airline meteorologists, working closely with their colleagues of the various governments concerned, are stationed at New York, the Azores and Lisbon. Each office interprets as many daily maps as are available and in addition prepares isobaric and wind charts for the 5,000 and 10,000 ft. levels, analyses radio-sonde reports, and constructs pictorial representations of the vertical cross-section along the route.

A trip forecast consists of a statement of weather conditions which the aircraft is expected to encounter along the route. The meteorologist divides the route into zones, generally upon a basis of approximately uniform wind conditions,—the end of each zone being designated by the total distance in nautical miles from the point of departure. In each zone a forecast is made for each of the following elements: general weather—amount, type, base and top of low clouds—amount, type and base of middle clouds—altitude of freezing level—visibility—state of sea—wind direction and velocity at altitudes of 1,000, 4,000, 8,000 and 12,000 ft.—and conditions expected at terminals and alternates. The forecast is concluded with a description of the isobaric configuration, location of fronts, expected weather conditions at fronts, and remarks pertinent to the execution of the flight. Prior to departure, the captain is also furnished a weather map of the area, and a vertical cross-section along the track showing anticipated weather conditions. A sample forecast, weather map and cross-section are attached.

Throughout every flight a meteorologist is on duty at one or more of the meteorological offices, to follow the progress of the flight and furnish additional information or advice as required,—a *prime function of the airline meteorologist*. A routine duty is to furnish an amendment to the original forecast based on each later weather map, indicating the changes which have occurred. By means of coordinates of latitude and longitude, information is also radioed to the Clippers, enabling the captain to draw each new weather map for himself in flight.

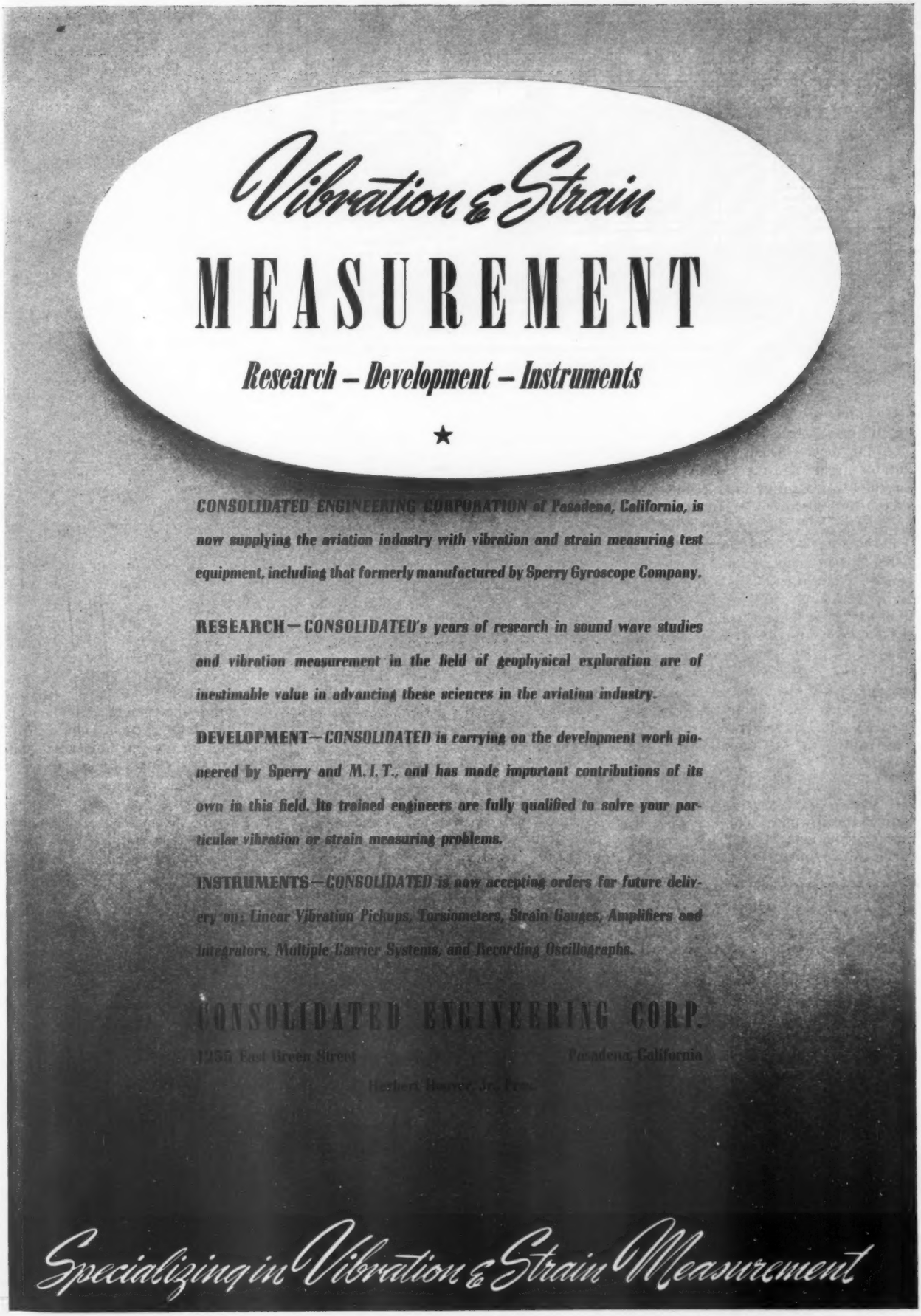
Before each flight the captain of the assigned crew, operation technicians and meteorologists prepare a so-called "flight time analysis," a combination product of the data from the weather forecast and the cruising control curves developed for the Boeing 314-A type Clipper.

Flight Time Analysis

The winds for each zone at the standardized altitudes are listed on the flight time analysis sheet under parenthesis "B." The columns headed by "A.S." are optimum true airspeeds for varying gross weights and each altitude. The ground speeds ("G.S." columns) are calculated on a specially developed navigational computer and the "zone transit" times are obtained by dividing the zones distances by the ground speeds. Addition of each "zone time" column will give the trip forecast time for that particular altitude.

The group of columns under parenthesis "A" have to do only with 3-engine performance at 1,000 ft. altitude. The one thousand foot altitude was selected for all 3-engine productions because it is the optimum safe altitude for maximum range. The optimum true airspeed for 3-engine performance is assumed to be constant for each altitude, 107 knots being the figure for 1,000 ft. "Ground speed returning" is calculated on the "computer" by using the same winds but reciprocal tracks.

This completes the uppersection of our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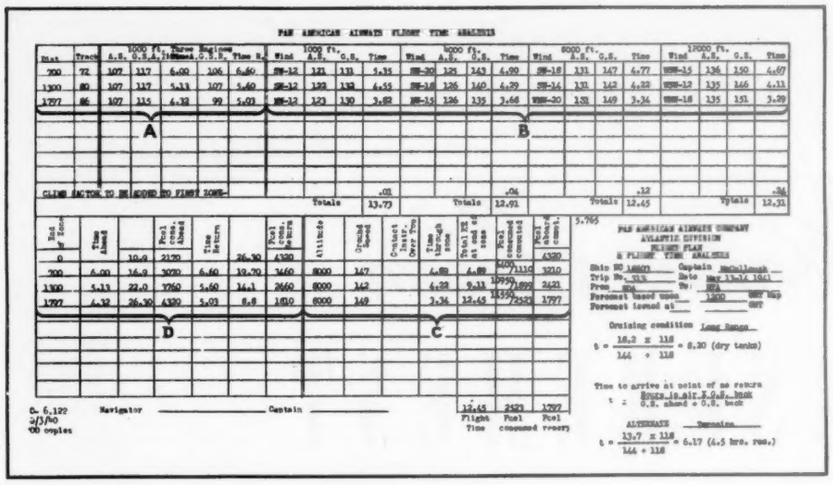


PAN AMERICAN AIRWAYS FLIGHT TIME ANALYSIS

Dist	Track	1000 ft. Three Engines A.S.	G.S.	Time	Time R.	Wind	1000 ft. A.S.	G.S.	Time	Wind	4000 ft. A.S.	G.S.	Time	Wind	8000 ft. A.S.	G.S.	Time	Wind	12000 ft. A.S.	G.S.	Time
700	72	107	117	6.00	106	6.60	SW-12	121	131	5.35	SW-20	125	143	4.90	SW-18	131	147	4.77	WSW-15	136	150	4.67
1300	80	107	117	5.13	107	5.60	SW-12	123	133	4.55	SW-18	126	140	4.39	SW-14	131	142	4.22	WSW-12	135	146	4.11
1797	86	107	115	4.32	99	5.03	SW-12	123	130	3.42	SW-15	126	135	3.46	WSW-20	131	149	3.34	WSW-18	135	151	3.29
			A										B								
CLIMB FACTOR TO BE ADDED TO FIRST ZONE									.01				.04				.12				.34
							Totals		13.79		Totals		12.91		Totals		12.45		Totals		12.31

End of Zone	Time Ahead		Fuel con. Ahead	Time Return		Fuel con. Return	Altitude	Ground Speed	Constant Heater Over Pos	Time through Zone	Total TC Time to end	Fuel consumed	Fuel con. Return	Fuel consumed corrected	Fuel con. corrected
0		10.9	2170		26.30	4320									4320
700	6.00	16.9	3070	6.40	19.70	3460	8000	147		4.88	4.88	2400	7110	9210	
1300	5.13	22.0	3760	5.60	14.1	2660	8000	142		4.22	9.11	10950	17899	2421	
1797	4.32	26.30	4320	5.03	8.8	1810	8000	149		3.34	12.45	13350	23253	1797	
			D								C				

12.45 Flight Time | 2423 Fuel consumed | 1797 Fuel reserv

C. 6,122
3/3/40
OD copies

Navigator _____ Captain _____

5.765

PAN AMERICAN AIRWAYS COMPANY
AVIATRIX DIVISION
FLIGHT PLAN
& FLIGHT TIME ANALYSIS

Ship NC 16603 Captain McCullough
Trip No. 33S Date May 13-14, 1941
From MIA To: RIO
Percent based upon 1200 GAL REQ
Percent loaded at _____ GAL

Cruising condition Long Range

$$t = \frac{16.2 \times 116}{144 + 116} = 8.20 \text{ (dry tanks)}$$

Time to arrive at point of no return
Hours to air E.S.S. back
t = G.S. ahead + G.S. back

ALTERNATE Barranca

$$t = \frac{13.7 \times 116}{144 + 116} = 6.17 \text{ (4.5 hrs. res.)}$$

Flight Time Analysis Chart.

flight time analysis sheet except that we still must select the altitude that will offer the most efficient and most comfortable flight. To the selected altitude forecast we add our fuel reserve (in hours), and then from our fuel consumption curves pick the corresponding fuel required for that total time.

The lower center group of columns (under parenthesis "C") is the detailed flight plan for the selected altitude. Immediately we may bring down from above the zone ground speeds and the zone times. The cumulative times are added, and their corresponding "fuel consumed" figures picked from the curve. The last column contains the remaining fuel at the end of each zone, consequently the last figure is the "fuel reserve."

Now we may proceed to parenthesis "D" under which there are the "three engine ahead" and "Three engine return" calculations. Here "Three engine" curve calculations are based upon "dry tanks," i.e., the total amount of fuel aboard. Columns "1" and "2" are the accumulated zone distances and the individual zone times respectively, brought down from above, and for "three engine ahead" operation. From there we skip to the end of the last period in the fourth column and enter the total gasoline presumably consumed at the end of the 3-engine flight. Opposite this figure (in column 3) we enter the total hours on three engines that we may expect at 1,000 feet for that total gasoline load. This figure is picked from the "three engine consumption" curve for that altitude. From these two bottom figures we work upwards, subtracting our individual zone "times" and picking off the corresponding fuel consumed. Consequently, the first row in those two columns, opposite "0" miles in the "End of Zone" column, will give us the reserve hours and fuel for a "three engine ahead" forecast.

Columns 5, 6 and 7 under "D" are concerned with "three engine return". In column 5 we list the zone times taken from above. The total fuel load and the equivalent "three engine" time are entered here, at the top of their respective columns. From those two figures we proceed to work as before, but down the columns, subtracting our individual zone times and entering the fuel required for those times. As above, the last row in the last two columns will give us the hours and fuel, if any, for a "three engine return" forecast.

This completes our "flight time analysis sheet", except for figuring the approximate "time to arrive at point of no return",—the formula for which is on the sheet, and self-explanatory.

Thus is each transoceanic flight planned out before takeoff. But no plan in the world is of any value unless it is executed with accuracy. To execute a plan accurately, is is necessary to have on hand an easily usable yardstick of performance. Pan American operating personnel have developed such a yardstick, now officially known in Pan American nomenclature as the "Howgozit Curve". Its purpose is to present to the crew aloft and to the flight watch ashore a continuous chart of information concerning any deviations from the predicted fuel consumption, winds, and track and the effect of these deviations on the fuel reserve remaining aboard the aircraft for completion of flight to destination, or return to point of departure, or for proceeding to a designated alternate.

When commercial long-range flights were first started, several new factors were introduced which made the problem of computing fuel reserve at any moment more difficult than it had been on the shorter routes. These were primarily:

1. In order to carry reasonable payloads it became necessary always to fly at a speed giving maximum miles per gallon. This introduced a variable speed over the route dependent on gross weight, altitude, and wind.

2. These variable speeds and gross weights resulted in a wide variation in power required at various points along the route and consequently a wide variation in fuel consumption.

3. Long-range forecasts were, of course, more subject to error with regard to wind velocity and direction and hence it became necessary to take variations in actual conditions from forecast into account whenever making a decision as to the reserve gas left aboard the aircraft at any point on the route.

It can be seen that the problem of determining the fuel reserve aboard the aircraft at any given moment, taking into account all of these variables, would be quite complicated and a lengthy process, using any system other than a graphical one.

A graphical solution in the form of the "Howgozit" curve answers any of the following questions at a glance, aboard the aircraft or on the flight watch office:

1. Has the aircraft burned more or less, at this point on the route, than was predicted?

2. Does it have, at this point, sufficient reserve to continue to destination with one engine inoperative?

3. If not, does it have sufficient reserve to return to point of departure with one engine inoperative?

4. When must a decision be made as to whether or not an alternate should be used?

5. Is the fuel consumption more or less than normal?

6. Are the winds being encountered more or less than predicted?

7. What will the probable reserve be to any given landing area, an hour hence?

In order to answer these questions, the "Howgozit" curve is built up in the following manner.

Data already described in the discussion on "Flight Time Analysis" are used to plot the following predicted curves:

A. A curve showing gallons consumed at any point on the route versus miles from point of departure.

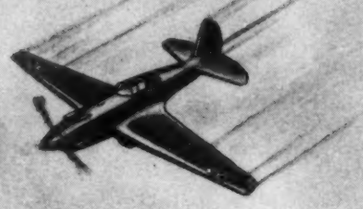
This tells at a glance how much gasoline should have been burned at any point on the route.

B. A curve showing the maximum amount of gasoline which may be burned at any point on the route and still leave enough to proceed to destination, with one engine inoperative, with a 30% plus 130 gallon reserve.

C. A curve showing the maximum amount of gasoline which may be burned at any point on the route and

3.8 to 5 pounds saved-

1. PESCO Stand-by Fuel Pump—a standard pump with new light-weight motor. Pump has diaphragm type relief valve with pressure regulation balanced to atmospheric conditions.



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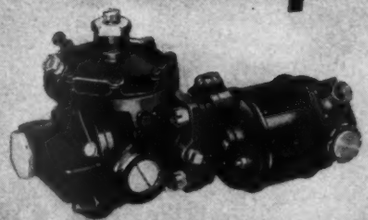
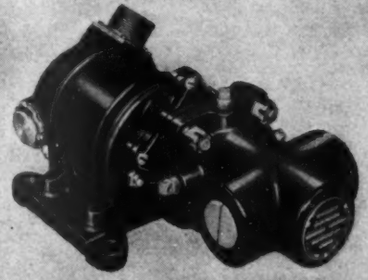
SPECIFICATIONS AND PERFORMANCE DATA ON PUMPS ILLUSTRATED

	Capacity G. P. H.	Pressure P. S. I.	Motor Hp.	Amps.	Volts	Weight Lbs.
1. Three Sizes	225	20	1/10	5	24	5.8
	350	20	1/8	8	24	7.0
	350	15	1/8	6.5	24	7.0
	650	8	1/8	7	24	8.5
2. One Size	325	18	1/10	6	24	8.2
3. Three Sizes	280	5	1/10	3.8	24	5.0
	360	15	1/8	7	24	6.6
	650	8	1/8	7.2	24	6.8

Can be supplied with or without motor base. Base weighs 0.2 lbs.



2. PESCO High Altitude Fuel Pump—with variable displacement for pressure regulation, eliminating internal vapor lock encountered at low atmospheric pressures.



3. PESCO Fuel Transfer Pump—a standard positive displacement pump with new motor. Model illustrated shows motor with base.

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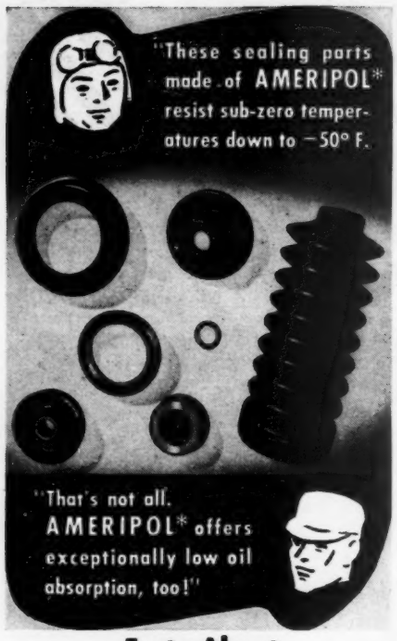
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"That's not all. AMERIPOL* offers exceptionally low oil absorption, too!"

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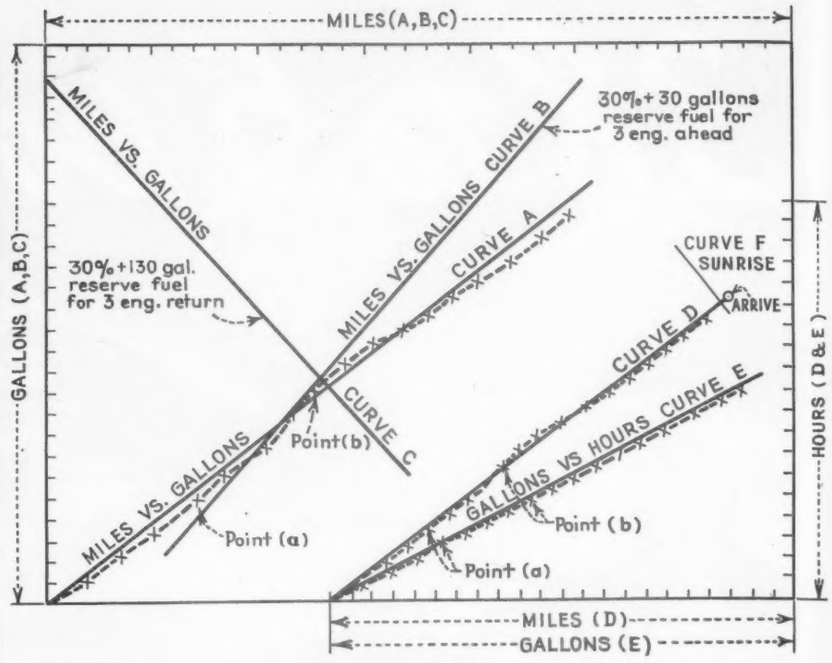

An Howgozit Curve.

still have enough left to return to point of departure, with one engine inoperative, with a 30% plus 130 gallon reserve.

D. A curve of predicted miles out versus time.

E. A curve of predicted gasoline consumption versus time.

The data for these curves are all computed and entered on the flight plan before departure, and plotted on the "Howgozit" chart immediately after takeoff. In flight the actual values of miles out and gallons consumed are plotted on the chart every hour, resulting in three curves similar to A, D and E but based on *actual* values determined in flight by the best navigational means available and fuel meters. To eliminate confusion these actual curves are made dotted lines.

In the accompanying illustrations is shown a typical "Howgozit" curve, the use of which is illustrated as follows:

At point (a) the aircraft is 500 miles out, has burned 50 gallons less gasoline than predicted at this point due to wind, has insufficient gasoline reserve to continue to destination on three engines, has more than enough reserve to return. At point (b) the aircraft is 900 miles out, has sufficient reserve to continue to destination or return to point of departure on three engines, and has burned 25 gallons more than predicted for this point due to winds and over-consumption. It is obvious at this point that the aircraft can continue, since it now has a 30% plus 130 gallon reserve, which will more than take care of any possible variations in wind or fuel consumption. On curve "F" it appears that arrival will be ten minutes before the predicted arrival time.

At no point in the flight has there been a moment when a decision depending on fuel reserve could not be made instantly, taking into account all known variables.

In summary, the problem of commercial long distance flight contains the same elements as any form of air transportation: safety, regularity, and economy. The chief difference is that the "economy" factor is in a kind of "neutral equilibrium" whereby small percentage changes in operating efficiency produce enormous changes in available payload. In this connection, and by way of looking toward the future, it should be understood that we seek to make maximum payload available to the public on an *annual* basis, rather than on each separate voyage. Therefore, our goal is to have the same payload available day in and day out. If there were no headwinds and no tailwinds such would be the case, assuming constant track and altitude. The winds cannot be exterminated, but their effect can be minimized—*by high-speed aircraft.* The airplane designer, neglecting practical considerations, may demonstrate that high speed is detrimental to payload on some particular flight. If he places himself in the shoes of the Sales Department, however, he will quickly recognize that more tickets will be sold *per year* if twenty seats are available every day than if thirty seats are available one day and ten seats the next—and the public will be much better satisfied as well. Thus, as a conclusion, we can say, "Exceedingly high long-range cruising speed, with resulting schedule regularity and constancy of available payload, is an essential requisite of profitable transocean aircraft."

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(*Continued from page* 178)

dividuals will stand a much greater chance of successful readjustment.

Meanwhile, the advice to small manufacturers seeking defense work is this: go to the Contract Distribution Office nearest you with complete information as to your plant's equipment. They will do all they can to assist you in getting defense work either from the government, or as subcontractors, from existing prime contractors. However, patient exploration on the part of each small businessman of all possible avenues of usefulness will go far toward lightening the excessive burden of government and improve his chances as an individual.

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